PUBLIC WORKS

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VOL. 71. NO. 8

A. PRESCOTT FOLWELL, Editor

W. A. HARDENBERGH, Asso. Editor

Timewasters

That 0.39 gal. of Wine:

The weight ef evidence continues to indicate that the cask of wine, after all the transfers enumerated in the June issue, contained 3.33 gallons, and Mr. Bevan, after checking the problem again, agrees. After all, wine is an expendible material, but we did want to know what happened to the surplus.

And the Boards:

There were 45 oak boards, 35 pine boards and 30 birch boards (if we haven't got our mathematics mixed up), and they were, respectively, 16, 24 and 20 feet in length.

Money, Money:

A man has $14.19 in coins and bills, but he can't change a nickel, a quarter, a dollar or a $5 bill. What kind of money does he carrry, asks the *ARBA?*

Motoring Pleasures:

Two motorists start at 8 AM, one going from Jonesville to Podunk Center and back; the other from Podunk Center to Jonesville and back. They meet for the second time (both on the way back) at 11 AM, and they are then 27 miles from Jonesville. The distance between the two metropoli is 78 miles. When and where did they meet the first time? *By John Bevan.*

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FOR TRICKLING FILTER SYSTEMS

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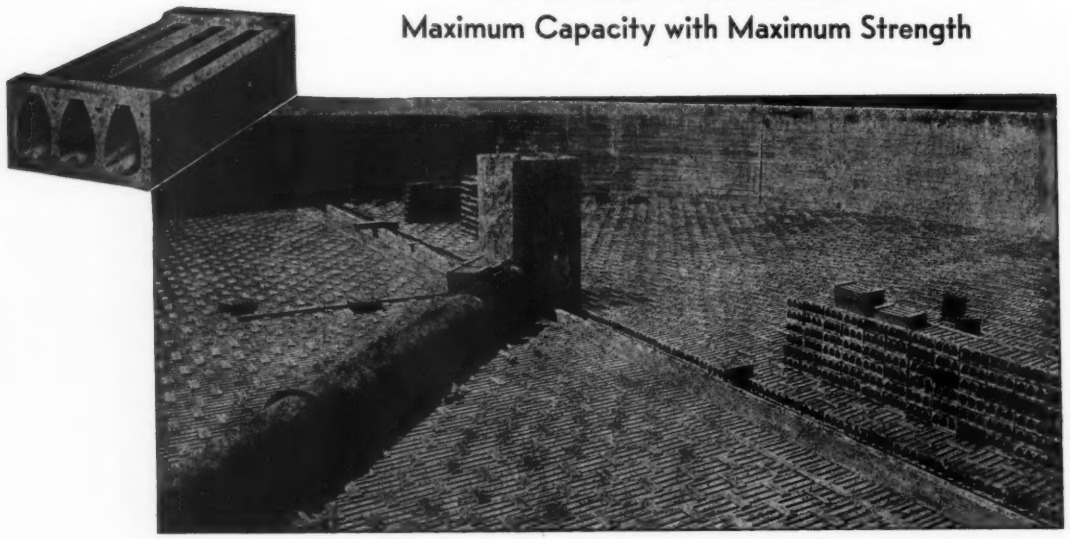
Maximum Capacity with Maximum Strength



A one-piece underdrain—Egg-shaped run-off channels for maximum flow and less flushing—Three long top slots combined with adequate duct area — Provide rapid, uniform and widespread ventilation of filter bed—Made of deaired and vitrified fire clay—low absorption and great strength—Cross Ribs reinforce each end, and increase ruggedness and strength—Salt Glazed surfaces—sanitary and corrosion proof—A unit balanced in size and weight with convenient handgrip—speedily laid—Shapes for the complete filter bed.

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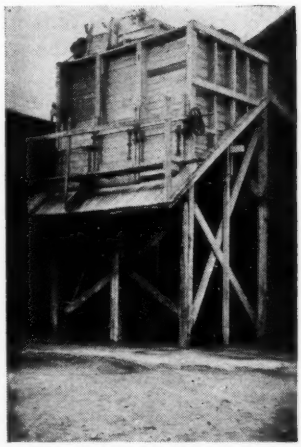
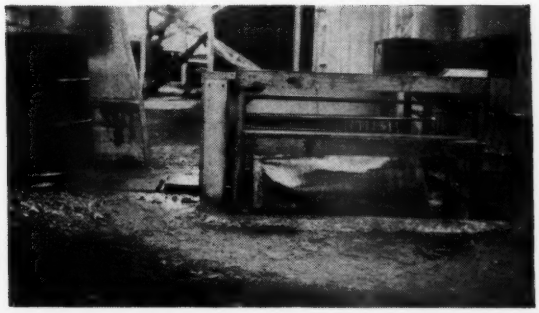
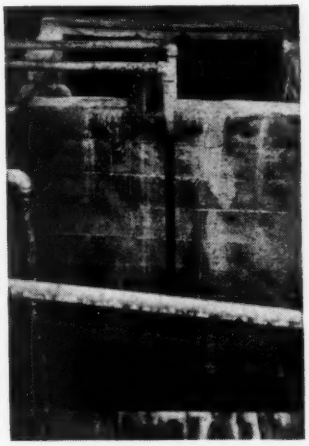




Left—Typical peel storage bin, showing hammer mill for grinding peel located directly over the bin. Above—Self-cleaning screen used in waste treatment. Right—a chemical precipitation pretreatment plant.



Treatment Methods for Waste From Citrus Juice Canning Plants

ODOR nuisances resulting from citrus wastes from juice canning plants and the detrimental effect of these wastes on sewer pipes and municipal treatment plants led to investigations by the personnel of the Texas State Department of Health, Bureau of Sanitary Engineering, into methods of treatment. A report was presented at the 1940 Texas Water Works Short School by C. A. Billings, Regional Sanitary Engineer of the Bureau, of which the following is an abstract.

Most of the canneries in Texas' Lower Rio Grande valley are located in cities and at first discharged their wastes into the sewers untreated. The average plant produces 20,000 gallons of waste per day with an average BOD of 1,500 ppm., which is equivalent to the wastes from 1,500 people, and represents a heavy added load on the treatment facilities of the average small town in which these plants are located. In fact, several plants were put out of operation altogether, and the municipalities had to regulate the character of wastes discharged into their sewers, setting as limits 250 ppm. of BOD, 150 ppm. of suspended solids, and 50 ppm. of acidity as calcium carbonate.

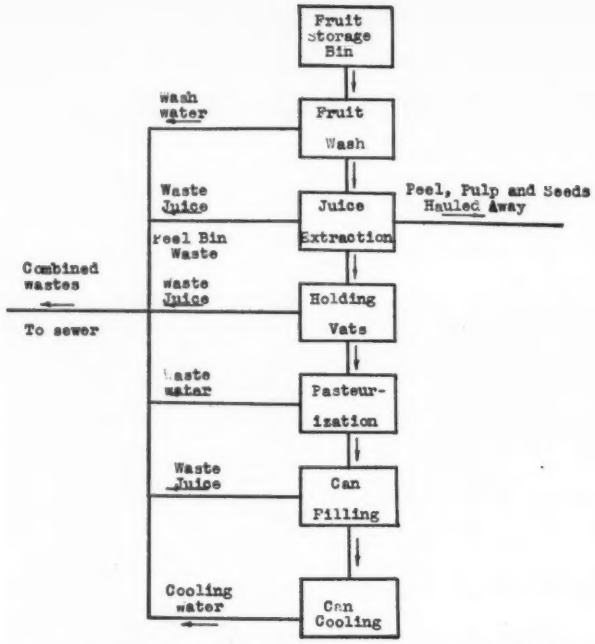
A number of the canners cooperated in experimenting with a view to meeting these requirements and learned that fine screening followed by precipitation with alum and lime produced a clear, alkaline effluent, by a process easily controlled and flexible. However, the BOD was too high, sewage reaching the plants with an average of 600 ppm. and peaks up to 2,000. Consequently the State Dept. of Health directed its work in search of more efficient methods of pretreatment.

The chief constituents of the waste are citric acid, sugars and a small amount of colloidal pectin. Acidity is neutralized and coagulation effected by a lime dosage of 4.3 gpg. per 100 ppm. of acidity; coagulation being assisted materially by addition of 3.5 gpg. of alum. With one hour's sedimentation this produces a clear straw-colored liquid; also BOD reduction up to 30%, the amount depending seemingly on the amount and character of the suspended solids present. Experiments with ferric chloride showed that the cost of this would be more than three times that of lime and alum.

Sand filtration proved to be impracticable because of rapid clogging, unless the pectin were first denatured with lime.

In experiments on a laboratory scale, activated sludge treatment and that supplemented by trickling filtration yielded the most promising results. When inoculated with yeast, with 4 hours aeration, BOD reduction averaged 21.3% and oxygen consumed reduction 78%. When inoculated with sewage, a BOD reduction of 95% was obtained at first but fell to 30% in a few days.

Florida had obtained good results with trickling filters treating citrus wastes with BOD values between 500 and 880 ppm. The Texas experiments were made on wastes ranging up to 2,000 ppm. When applied continuously, the BOD reduction was only 20%; but with intermittent dosing, it averaged 71.9% from a



Flow diagram of canning operations and waste components

raw figure of 947 ppm. when the mean temperature was only 64°. Applying the sewage at different rates, the reduction in BOD varied from 1260 ppm. at 0.5 mgad. (with a raw BOD approximating 2,000) to 510 at 3 mgad.

A procedure has been developed from experience and laboratory tests which seems to be fairly satisfactory. The first step in the problem of handling these wastes lies in the segregation of the various products of the different stages in operation. For each 1,000 gallons of juice, the wastes will total about 1,490 gallons, made up as follows:

Peel bin waste, 26.1 gals., BOD 50,000; fruit wash water, 528 gals., BOD 110; cooling water, 817 gals., BOD 28; pasteurizer water, 38 gals., BOD 10; floor wash water, 76 gals., BOD 4,050. Average BOD, 1,602.

The peel bin waste is the most serious problem, but since the quantity is small, it is recommended that this be trapped by a separate system, led into a receiving tank and disposed of into the soil or hauled away. Efforts also should be made to reduce the amount of peel bin loss, which has been accomplished by installing hammer mills for grinding the peel to a more absorbent pulp. At one plant, the entire plant discharge showed a BOD of 1,000 ppm., which was reduced to 220 ppm. after the hammer mill was installed.

Several thousand experiments indicate that chemical precipitation, using lime and aluminum sulphate, will effect a reduction of about 30% in the organic content of the floor washings. By mixing this partly treated waste with the relatively stable cooling water, a still further reduction in load is accomplished. It is estimated that by careful operation, floor washing BOD can be reduced to about 1,700 ppm. BOD. A reduction of 30% brings the BOD to about 1,200; the cooling water is about 11½ times as great in volume as the floor washings, and this dilution would produce a final waste with a strength of not more than about 115 BOD. The cost of alum and lime average $1 per day for the approximately 75 to 100 gallons per hour of floor washings, regular personnel handling this work.

The use of aeration also appeared to be effective and reductions as high as 85% were obtained in experimental work. Stone and sand filters developed septic conditions, even at low rates of 1 mgad.

Sewage Plant Operation at Grand Rapids, N. D.

OPERATION data for the Grand Forks, N. D., sewage treatment plant from March, 1939, to March, 1940, have been received. This plant was described briefly with added data on multiple digestion of sludge by K. W. Riley, city chemist, in the January, 1940, issue of PUBLIC WORKS.

The amount of gas produced during the year averaged 436,000 cubic feet per month, or 0.86 cu. ft. per capita, per day. Analyses of the gas showed CO_2 content to be 29.6%, H_2S always present, and Btu of 630 per cu. ft. Per million gallons of sewage pumped, gas amounted to 16,500 cu. ft.; per thousand gallons of sludge, gas amounted to 735 cu. ft. The average flow of sewage was 955,000 gpd., or 53 gallons per capita. The average sludge production was 22,100 gallons per day, or 1.23 gallons per capita per day. Screenings removed amounted to 2.35 cu. ft. per million gallons of sewage; grit removed amounted to 9.31 cu. ft. per million gallons of sewage.

The average temperature of the raw sewage was 59°; the turbidity of the raw sewage 1100 and of the effluent 227; composited samples of raw sewage showed as follows: Suspended solids, 850 ppm.; dissolved solids, 960 ppm.; total solids, 1887 ppm.; and volatile solids, 434 ppm. The pH of the raw sewage averaged 8.18; of the effluent 7.87, and of the two digesters 7.36 and 7.14 respectively. Raw sewage had an alkalinity of 330, the effluent an alkalinity of 351; and the digester of 3520.

Results of plant operations showed the following removals: Settleable solids, 99%; turbidity, 89%; volatile solids, 59%; total solids, 49%; chlorine demand, 22%; and BOD, 39%.

Two unusual sources of trouble in operation were contamination on two occasions with heavy mineral oil, and on another occasion a heavy load of feathers. The former involved thorough cleaning of the plant and the lift station involved; the feathers were detected and eliminated before they interfered with plant opration. Floating solids on top of the sludge in the primary digester plugged the gas exit twice during the year, and removal of some of the top floating layer was necessary.

Aside from some excellent charts the report contains a complete inventory of the entire plant equipment. This includes not only major equipment, with the serial number and complete data on each item, but also small equipment, laboratory apparatus and chemicals.

Olaf Nelson is sewage commissioner; J. B. Kleven is superintendent; K. W. Riley is city chemist; and the operators are Glen Carson, A. B. Everson, R. A. Haves and K. F. Coulter.

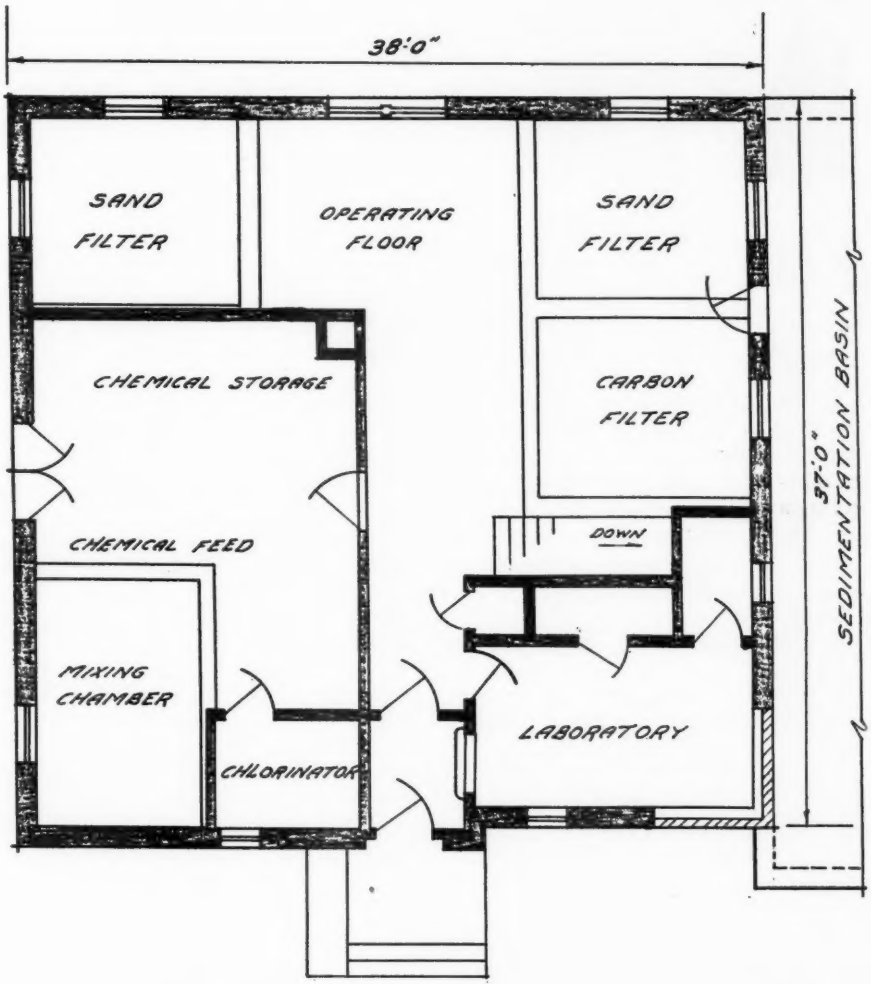
New Zoning Requires Parking Facilities

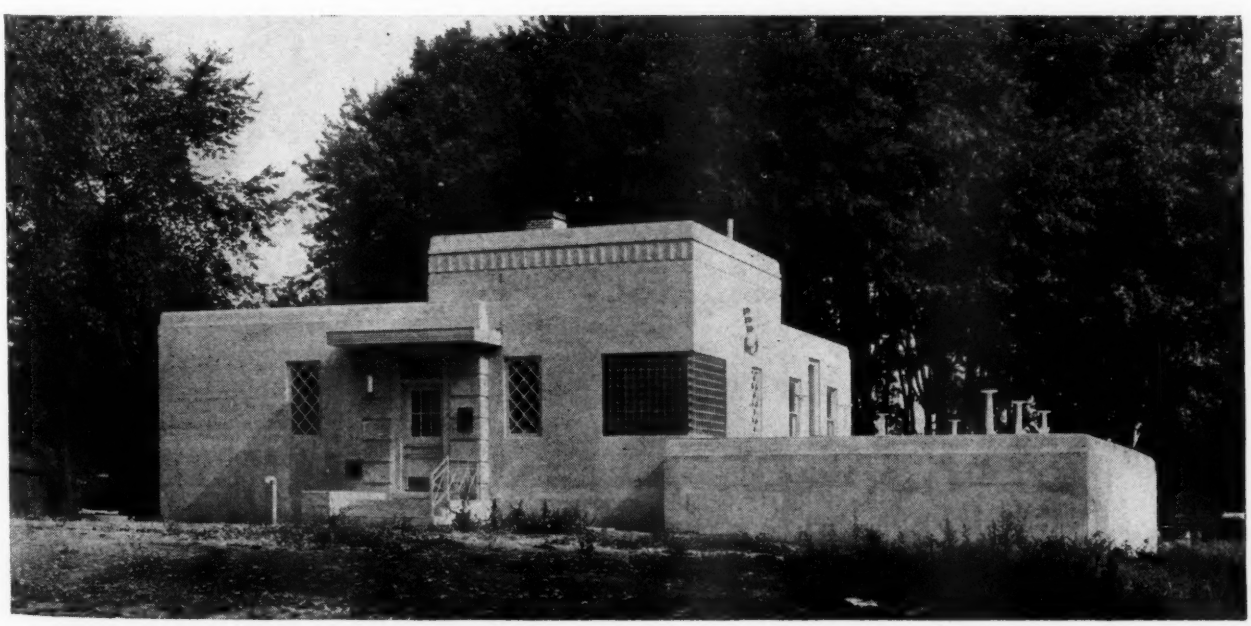
Off-street parking facilities are required for all new multiple dwellings, row houses, theatres (one parking space for every two dwelling units and for every ten seats) by the new zoning ordinance of Evanston, Illinois. The ordinance also reducees the amount of land zoned for commercial purposes by 20 per cent, and the amount zoned for multiple dwellings by 50 per cent, and creates a new district in which two-family dwellings and row houses may be constructed. Bridgeport, Connecticut, also recently adopted a revised zoning code.—Public Management.

Attractive Plants:

Water Purification Plant at Frankenmuth, Mich.

This attractive filter plant building was designed by Pate-Hirn, Detroit, Mich. Filter building is 37'x40'; coagulation basin is 22'x40'x16' deep; clear water reservoirs 26'x36'x10½'; filtration cost, $46,500; total including distribution system, $86,000. C. H. Donaldson, Melvindale, Mich., Contractor. Floor plan at right; view of building below.





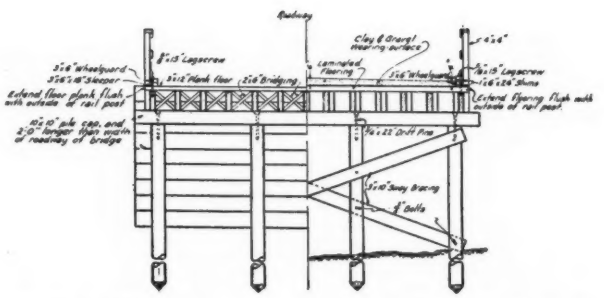
Royal S. Clark

WPA Bridge and Culvert

By ROYAL S. CLARK
County Highway Commissioner

PLATTE COUNTY, NEBRASKA, whose principal industry is agriculture, has been severely hit by drought during the past seven years. This has necessitated reduction of the tax levy for county road and bridge work, and also supplying as much work as possible on county projects for farmers and also for WPA labor. In general, local farm labor seems to be more adaptable to maintenance and the ordinary run of repair jobs, and WPA labor to new road and bridge construction; the former because farm labor is easily and quickly obtainable near the job, the work requires little equipment, and what is needed is confined largely to teams and fresnoes and other equipment that the farmers themselves can provide; while employment of WPA labor on maintenance work is forbidden, and construction work can be operated on a large scale, with regular construction crews that can be moved from one part of the county to another.

However, road construction has become a highly mechanized process in which large amounts of hand labor cannot be used to advantage; therefore the county, during the past year, sponsored WPA construction of bridges and manufacture and installation of reinforced concrete culvert pipe. Bridge building has been in constant operation since late in the summer of 1939, and culvert manufacture and installation since the first of the year 1940.

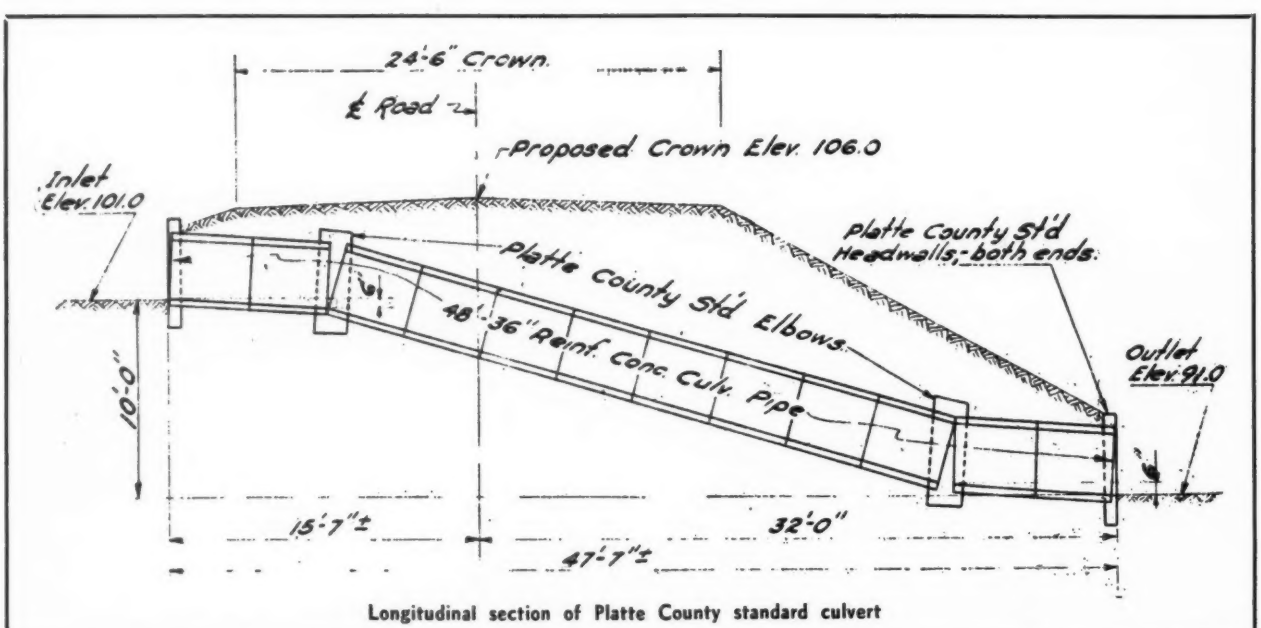


Section of end bent — Section of intermediate bent

Bridge Construction

The county contains many dry streams or gullies which must be crossed by structures with a span usually not exceeding 32 ft. These gullies are constantly undergoing change by filling with sediment or scouring; thereby limiting the useful life of such structures. Because of this and the necessity for maximum economy, pressure-treated creosote timber was selected as the material for constructing the bridges, this being adaptable to short-span construction, having a relatively high degree of permanence and salvage value at a relatively low initial cost.

In designing all drainage structures, the county



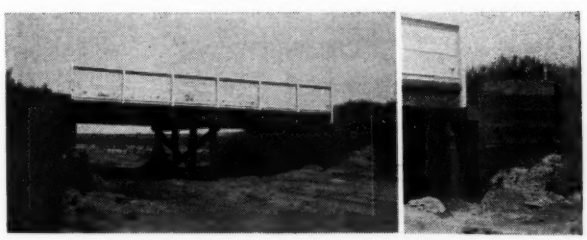
Longitudinal section of Platte County standard culvert

Construction Projects in a Nebraska County

Reduced tax income is compensated for by employing WPA labor and adequate equipment on bridge and culvert construction.

uses Talbot's formula for calculating the water way area. The drainage areas are obtained either by actual surveys or from aerial photographs or other maps. Aerial photographs, on a scale of 8″ to 1 mile, are obtainable from the local Agricultural Conservation Program office. For large areas we use soil maps of the county, scale 1″ to 1 mile, which show all but the smallest streams and drainage courses and are obtained from the U. S. Dept. of Agriculture.

To reduce to an absolute minimum the time and expense of preparing plans, the writer prepared a single standard plan from which all bridges from 11 ft. to 31 ft. span inclusive could be built; also mimeograph bills of lumber for bridges of each particular

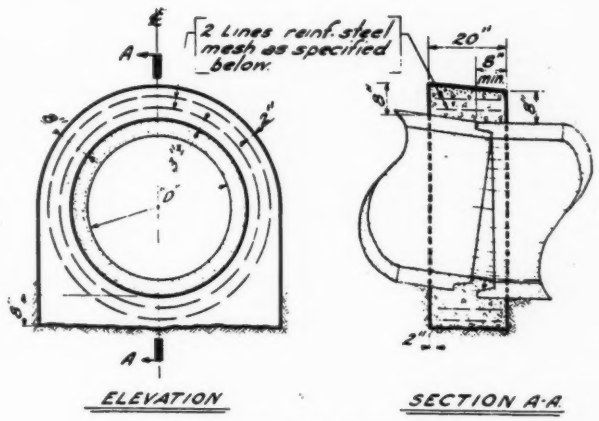


Two-span bridge and abutment detail

span, which are set up in such a way that it is necessary to fill in but a few blank spaces in order to use them for a particular job. This not only reduces the office engineering necessary but has the following advantages: (1) The foreman and erection crew have become thoroughly familiar with the construction and exceedingly efficient at it; (2) materials for any given structure are quickly and easily selected from stock in the county yard; (3) it is possible to buy larger quantities of lumber more intelligently and thus secure more favorable prices; (4) the bills of lumber facilitate rapid making of preliminary cost estimates.

In general, the standard plan conforms to the requirements of the Nebraska Highway Department's standard 15-ton capacity timber trestle bridge; but a few details of the Platte County standard will be described briefly.

To decrease the high maintenance cost of the ordinary 3″ x 12″ plank floor, the writer, at the suggestion of the Service Bureau of the American Wood Preservers Ass'n, adopted laminated pressure-treated creosoted fir or yellow pine 2″ x 4″s laid on edge across the stringers, covered with a wearing surface of 4″ to 6″ of dirt and gravel. The flooring strips are surfaced on one side to give exactly 1¾″ thickness



Details of standard elbow

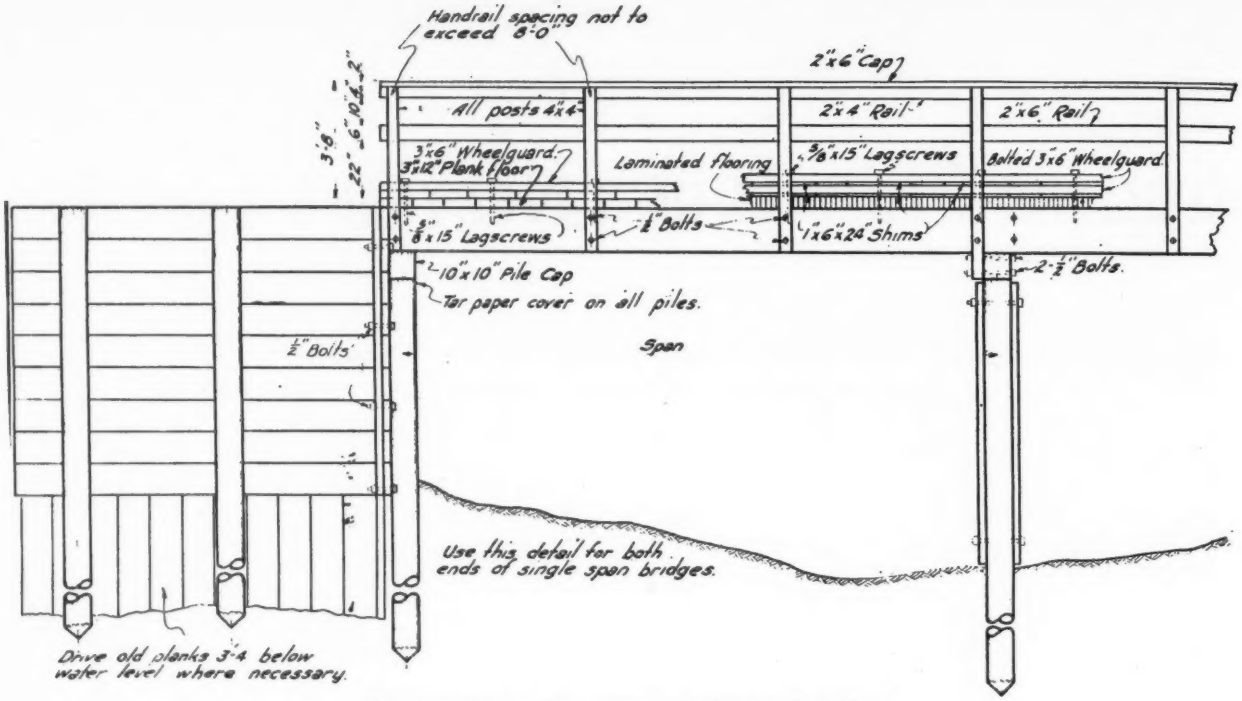
to facilitate laying the floor square with the bridge, while the edges are left rough to minimize any creeping tendency which wearing surface might have.

Another unusual detail is the wheel guard, which is used on all laminated floor construction. Each guard consists of two lines of 3″ x 6″ timber, one above the other, the full length of the bridge; the bottom timber resting on 1″ x 6″ x 24″ timber pads, located one at each guard rail post and others midway between them, which raise the timber 1″ above the floor. Similar pads are placed directly above the others, between the bottom and top timbers, separating them 1″. At each pair of pads a bolt or lag screw is passed through both timbers and the floor into the stringer below. The opening beneath the bottom timber serves to drain seepage from the wearing surface, which is made 4″ thick at the sides, bringing the road surface level with the upper scupper so that surface run-off can escape.

These bridges are built by a crew consisting of a foreman and 7 to 12 men, equipped with a skid-rig pile driver, hoist and other smaller tools. An average of 24 to 30 working hours is required to remove the old structure and erect a new one of 16 ft. to 20 ft. span. Following this, a back-fill crew constructs the approaches, which provide considerable work for WPA labor because in most cases the new bridge has been set 3 ft. to 5 ft. higher than the old to provide a large waterway—necessary chiefly because of the silting up of the channel.

Reinforced Concrete Culverts

The county has in operation a plant for manufacturing 24″, 30″, 36″ and 48″ reinforced concrete culvert pipe to conform to the requirements of the Nebraska



Elevation, Platte county standard timber trestle bridge

State Highway Department, the WPA furnishing all labor, pipe forms and a portion of the materials.

Having surveyed the drainage area and the road at the site of a proposed culvert, the engineers design the structure and stake it out for the installation crew.

In a high percentage of the cases the upstream end of the culvert is several feet higher than the downstream end, necessitating one or more angles in the culvert grade. At each of these an elbow is built substantially of concrete. These are designed so that each set of forms can be used many times, fitting any installation regardless of the degree of the angle in the pipe. The elbow consists of a collar 8″ thick and 20″ wide minimum, extending around the top 180° of the pipe and thence vertically downward to a point approximately 8″ below the outer surface of the pipe invert, the whole being reinforced with two rings of steel mesh of the same weight as that used in the pipe being installed.

The form used for the elbows consists of two horseshoe-shaped pieces which are slipped vertically down over the pipes, one on each side of the joint and 20″ apart, which are connected by removable side boards or lagging; the form around the lower half of the pipe being made with scraps of wood. Besides providing structural strength to the joints, these elbows serve as cut-off walls to stop seepage which might otherwise follow the pipe through the fill.

The writer believes that future traffic requirements will probably demand wider highways and is attempting to anticipate this by making each culvert as long as he reasonably can to allow future widening.

In all of this work the county has had the hearty and continuous cooperation of all the WPA officials connected with it; as a result of which three fine WPA crews have been organized, two of which can install in excellent fashion any structure, bridge or culvert, assigned to them, while the third crew has been performing to very good advantage backfilling up to or over the completed new structures. To date 22 bridges have been erected of the design described above and ranging from 15 ft. to 31 ft. in single span construction, and up to 38 ft. span in double bent construction. Approximately 2800 lineal feet of reinforced concrete culvert pipe have been manufactured and about 668 lineal feet of it have already been installed.

All work has been prepared and executed for the county under the general supervision of the County Supervisors, Ed. Asche, Otto Rudat, E. E. Johnson, John Brandl, Walter Loseke, Henry Moeller and Hilding Nelson, by the County Highway Commissioner, Royal S. Clark. For the W.P.A. the work was prepared and executed by Platte County Project Supervisor Elwood C. Smith, under the general supervision of D. F. Felton, State Administrator, with Charles H. Beal, District Manager, and T. J. Walsh, Area Engineer.

PLATTE COUNTY

Quantities of Materials in Standard Creosoted Timber Bridge, 2"x4" Laminated Floor.

20' Span--20' Roadway

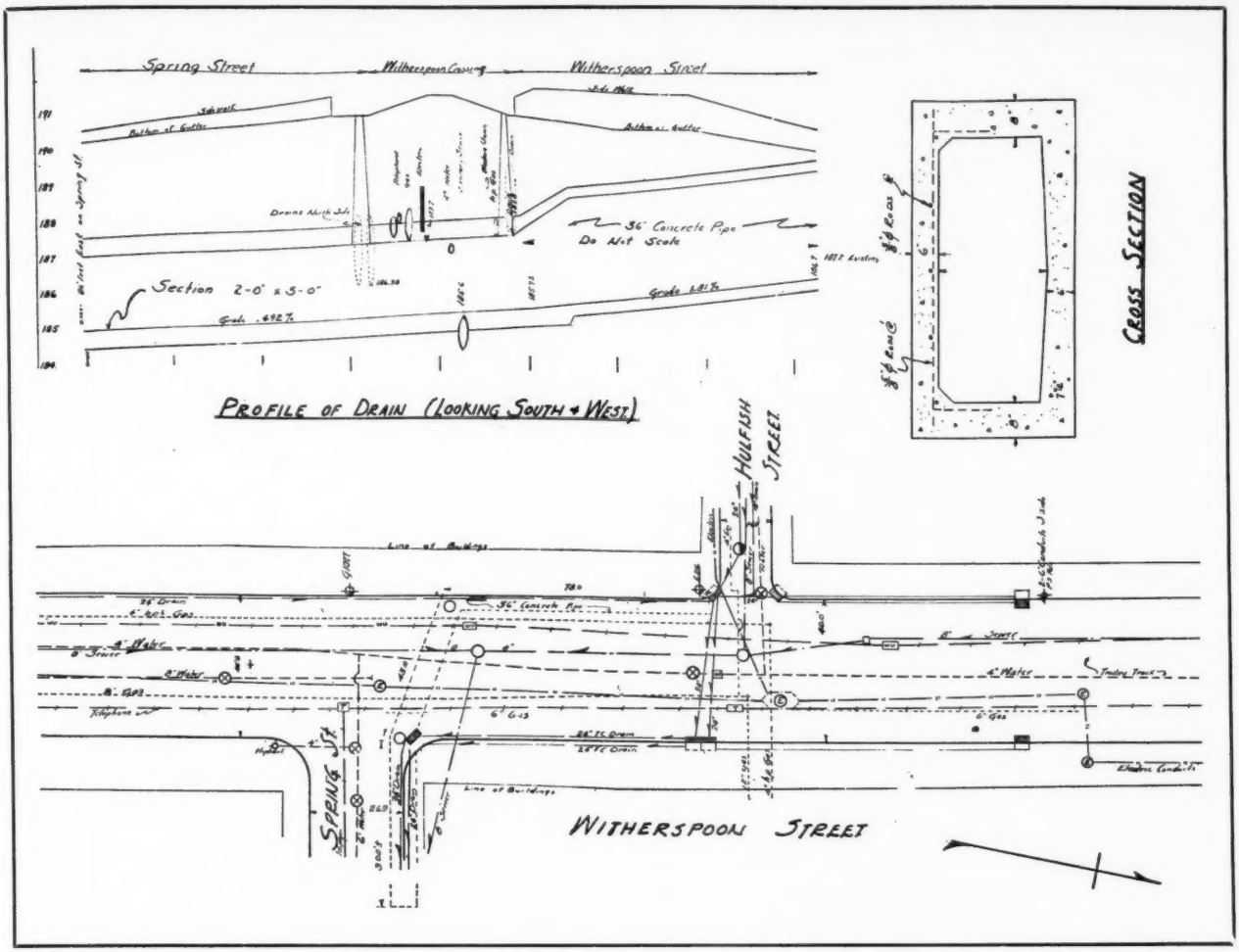
Bridge No_____ Location_____

Acres Drained_____ X-Sectional Area required_____

Clearance: Stream bed to bottom of Stringers_____

Stream bed to center line of road_____

Item	No. Pieces	Dimension	Lgth	No. B.M.	Creo. Trtm't	Unit Price	Amount
Superstructure:							
Handrail	4	2"x6"	20'	80	None		
Handrail	2	2"x4"	20'	27	"		
" Posts	2	4"x4"	20'	53	"		
Wheelguard	2	3"x6"	20'	60	"		
Wheelguard	2	1"x6"	14'	14	"		
Wheelguard	2	3"x6"	20'	60	8 lb.		
Wheelguard	14	1"x6"	2'	14	8 lb.		
Floor		2"x4"	2850'	1900	8 lb.		
Stringers	15	4"x16"	20'	1387	8 lb.		
Bridging	6	2"x6"	16'	96	None		
Substructure							
Caps	2	10"x10"	22'	366	8 lb.		
Backing Plk.		3"x12"	22'		8 lb.		
Wing Plank		3"x12"			8 lb.		
Nailers	4	3"x6"	16'	96	8 lb.		
Abut Piling	8	8"tip			8 lb.		
Wing Piling	8	8"tip			8 lb.		



Problems in Designing and Building a Reinforced Concrete Drain

By I. RUSSELL RIKER, C. E.
Engineer for Princeton, N. J.

PRINCETON, N. J., has been adding to its storm water system with the help of the W.P.A. for several years. However, there was one section which remained untouched due principally to the fact that the job of remedying this particular section seemed too much for the W.P.A. men who have been doing all new work in Princeton for the past several years and funds were not available to hire a contractor.

This section of the storm water system is in one of Princeton's main thoroughfares, Witherspoon Street between Spring Street and Hulfish Street, which has long been a bottle neck. The main drainage system of the Borough, which consists of a brook known as Harry's Brook, was covered by a special re-enforced concrete flume (described in PUBLIC WORKS, Page 12. in the August 1938 issue). Harry's Brcok extends throughout the entire length of the town and crossed Witherspoon Street at Hulfish and Spring Streets. It was partly covered years ago by installing two 24" drains across Witherspoon Street, but these pipe lines were laid on a flat grade and were far too small to take even the average run-off.

The construction of Palmer Square, the new civic center for Princeton, involved additional buildings and paved streets, resulting in a greater and much quicker run-off, which naturally made a bad matter worse. Witherspoon Street in the vicinity of Hulfish Street was flooded during heavy storms sometimes to a depth of 8". In 1935 a design for a new drain across Witherspoon Street was made, but it was not until the summer of 1939 that the work was done. As is shown in the drawing accompanying this article, the street was crowded with utilities, including a trolly track on the surface with underground telephone, high pressure and low pressure gas, sanitary sewer, water, telegraph, storm drains, and a high-tension electric line carrying approximately 22,000 volts.

The problem in the design was to secure a large enough section to care for the maximum run-off and yet not move any more of the utilities than necessary. As

designed, the only utility that had to be moved was the water, and this was done by cutting the 4" main and installing a 45 at each side of the storm drain and looping over it. The section adopted for the storm drain was 2 ft. high and 5 ft. wide inside dimensions, as shown on the drawing. Part of the sanitary sewer was enclosed in the floor of the concrete structure while part of the telephone, gas, and electric lines were enclosed in its roof. In places where pipe lines were placed in the roof, they were protected by water-proofing material and the roof section specially re-enforced at this point. The bottom of the structure was poured first, then the forms for the two sides were placed on the bottom and poured, after which the roof was poured as a slab.

In order to not interfere with traffic, it was necessary to open one side of the street and take the exact elevation of the pipes crossing the proposed drain and then back fill, and open the other side and take the elevations before the final design could be made. It was found, however, that the actual elevations compared very closely with the records of the various utility companies. Due to the fact that the drain had to be placed at such a low elevation to avoid the utilities, it was necessary to continue it down Spring Street for approximately 300 ft. at a grade of approximately .5% before the grade of the old lines could be reached. The line on Spring Street fortunately was on a grade of approximately 2%.

The work was done at a time when traffic is about at the lowest point, although traffic was never stopped during construction work. A concrete mix of 1-2-4 was used; ¾" stone being mixed with sand and gravel. The drain has now been in service nearly one year and we have had some severe storms. Witherspoon Street has never been flooded since its completion and it appears that the bottle neck at this point has been eliminated. The cost of the work to the Borough was $430 for the culvert itself, not including the pipe leading to and from it. Trucking the excavated material away and returning some of it was a big item. The W.P.A. furnished labor to the amount of $11. The writer had charge of the design and construction.

Blacktopping Streets at 8 Cents a Yard Solves Maintenance

By E. Straatsma, Town Clerk, Sioux Center, Ia.

Our most interesting and profitable maintenance job during 1939 was the blacktopping of our streets. Our streets were graveled in 1929, and the maintenance of these streets amounted to a large sum every year. Regraveling was necessary every two or three years. During dry seasons, when we usually have high winds, the dust problem was more than annoying. It was impossible to keep any doors or windows open at such times. Traffic would raise so much dust that the resulting clouds necessitated closing all doors and windows, even though it might be too hot to remain indoors with them closed.

The Town Council began investigating the matter of blacktopping. We visited several towns and cities throughout the state and satisfied ourselves that this was one sure method of obtaining dustless streets. The subject was introduced to the people, a resolution of necessity passed, and only four of the 1675 population had any objections to offer. A black top surface was placed on all streets at the rate of 8 cents a square yard, and the cost charged to the abutting property. During the period of two days set aside for the payment of these assessments, all assessments were paid except for $120. The entire project cost the town $5,000, or at the rate of $1,000 per mile for the five miles of surface treated, and we are now out of the dust. We obtained WPA cooperation on the project, this covering most of the labor and being a big help in keeping the cost down.

Setting Corrugated Culverts in Soft Ground

A reader from a middle western state sends us the following inquiry:

"How will a 135-inch sectional plate round pipe #5-gage stand up if used on a soft bottom river bed, quick sand bottom? Or would a #3-gage be preferable? There will be very heavy loads going across the above named pipe.

"We have a case here where a township installed two 72-inch x 40-ft. long 12-ga. corrugated copper-steel pipe in one length, in soft bottom ground, side by side close together, then built end walls on each end. Vertical struts were set in the pipes, raising the vertical diameter 4". They then started to fill in with 95-H.P. Cat tractors. By the time they got through with filling and graveling, the upright posts in the pipe used for strutting were from 6 to 8-inches too short, except that the outside end posts stayed in place protected by the end walls. Now the pipe is only about 3-ft. wide in the center. Would the soft bottom and the light gage be the cause of this trouble?"

Our reply to this inquiry, which was forwarded by mail, follows:

We have had no experience with culverts as large as 135-inch but according to computations and good standards, assuming a H-20 loading, you will have to use a 3-gauge, as the 5-gauge will not carry this loading. If, on the other hand, you are considering an H-15 loading, the 5-gauge is heavy enough. Your local highway engineer can talk with you regarding these loads. These assume the fill over the pipe will not exceed 10 ft.

We would not recommend that any culvert, especially one of this size, be placed on soft mud. You should take out some of the mud material and replace it with stable material such as broken stone or gravel; in other words you should stabilize this river bottom by adding coarse material. You will have to use your own judgment in regard to how bad the mud is, from the bearing viewpoint, and how deep your stabilizing should go.

In regard to the two 72-inch pipes that became really egg-shaped, the trouble was that filling was carried on with such heavy equipment and so well packed down that the pipes were forced inward. We do not know that this would indicate that the pipe gauge was too light; pipe gauge is really dependent upon loading over the pipe. If the cover over the pipe did not exceed 10 feet, a 10-gauge pipe should have been sufficient; if more than 10 feet, the pipe should probably have been 8-gauge.

When compacting fill in this manner, culverts have to be braced horizontally as well as vertically; in fact, horizontal bracing is much more important when fill is compacted along the sides of a big culvert; by the time cover is being placed over the culvert, the sides are packed in so tightly that there is very little, if any, danger of flattening.

In using this information, please remember that long-distance engineering always involves some guesswork and that the man who is 1,000 miles away cannot always give the kind of advice that he would if he were on the job. We have to imagine or assume some conditions, which may not always be right.

The Editor's Page

An Important Contribution by the Highway Industry

The development of highway construction equipment over the past ten or fifteen years has been remarkable. Earth-moving equipment is now available that will cut through hills, fill low places and unreel a finished subgrade at an amazing pace. So widely is it distributed that any needed amount of it can be mobilized without difficulty at one place for the construction of a needed highway or airport. In addition to this, the rate of surface construction has also greatly increased, and new types of surfaces have been developed that will carry the heaviest loads. Modern equipment that will lay more than a mile of finished surface a day is now commonplace.

Similarly, maintenance equipment and maintenance methods have been improved and speeded up. In addition to this, a sound knowledge of the need for drainage and the methods of providing drainage, has permitted the utilization of natural soils for bases to an extent undreamed of twenty years ago. This, in turn, allows the use of flexible type pavements for many places where, formerly, only the heaviest rigid surfaces were considered as being sufficient.

Whatever the needs for more and better roads may be, the highway industry seems fully capable of meeting them with speed and economy.

"Timewasters," Our Readers and Their Mental States

"In what sort of mental condition," says one of our readers, "must a man be to evolve such a problem as that from Mr. Bevan in the February issue (page 7). Or is it just a peculiar talent—an extraordinary imagination, similar to that which brought forth such productions as 'King Solomon's Mines'? A bandit, mules, bars of bullion, a death, a studied division, a change in the carrying capacity of the mules, and finally the unusual clue to the solution—that the product of the dollars equals the weight of the bullion and 75 pounds additional. It is said that it takes a thief to catch a thief—too comprehensive, I believe—but it occurs to me that possibly it takes one to trace the clue who can work himself into the mental state in which Mr. Bevan was when he imagined or conceived or dreamed the problem. Anyway, I believe that in one way or another, partly by computation and partly by trial I have arrived at the answer."

Well, for that answer, our readers must turn to a previous issue. But on page 5 of this issue will be found another problem or two, presenting also the possibility of mental trouble. And perhaps such foolishness as "Timewasters" is out of place on the editorial page of a usually serious magazine; perhaps out of place on any page of it. There is another side to the question, though we will have to discuss that at some other time; meanwhile many hundreds of our readers tell us that they get lots of enjoyment out of our monthly program of mental exercise.

Engineers, National Defense and Preparedness

Engineers and technical men have always had important parts in any plans for national defense because they are essentially managers, with their ability and experience in this line supplemented by technical knowledge. Many of them, we believe, are reserve officers; and probably many of them (as we write this) are wondering if and when they are to be called to active duty. Present doubts may be resolved before this issue of PUBLIC WORKS reaches them. But even then there may often arise the question as to whether more valuable service can be rendered in their present positions.

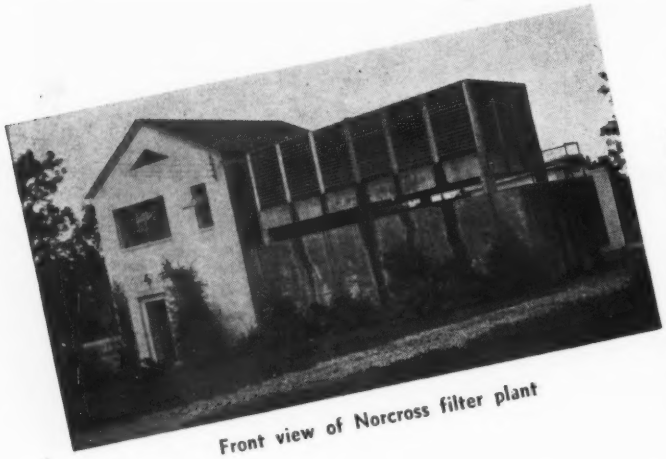
The proper operation and maintenance of public utilities—highways, airports, water supply and purification systems, and sewage disposal plants—are of tremendous importance to the country, and especially so in any major effort. It is not necessary to enlarge on this subject, for it is, or should be, apparent to all. The drawing of experienced men from such work, unless they can be replaced by assistants who are also capable and well trained, would be a mistake.

The writer of this has for some years been one of the senior officers of the Sanitary Corps, which is composed largely of sanitary engineers and others with training in this line of work. In planning for personnel, it has been the policy of the Sanitary Corps to draw from many sources, but from none of them enough men to cripple the organization. This seems a sound procedure, and we believe that it should be followed whenever possible.

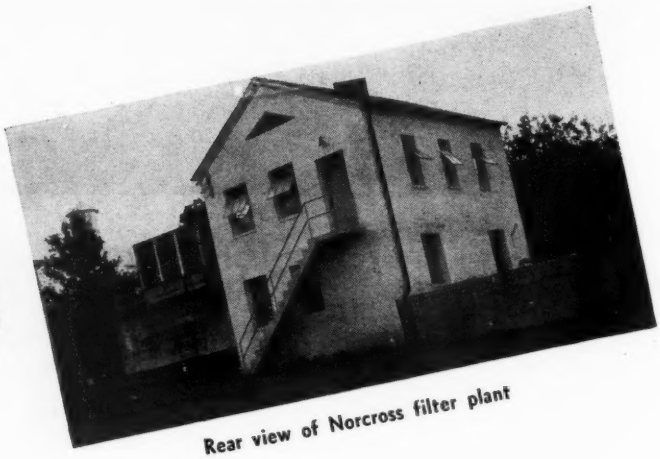
The Stream Pollution Bill Is Still Drifting

The latest word, as we go to press, is that the legislation authorizing federal regulation of stream pollution is still unsettled. The House of Representatives has adopted the Mundt amendment which in effect removes any teeth that the program may have boasted originally. This amendment simply provides for regulation of discharge of additional sources of pollution into navigable waters or their tributary streams, and makes no provision for the reduction of pollution now entering the streams. The Public Health Service through an administrative agency will judge whether new sources of pollution are excessive and require abatement.

If the Mundt amendment is adopted by the Senate, the fight to eliminate the gross pollution in so many of our streams will have been lost temporarily. We have never been in favor of any program that would unduly burden industry, but we have been strongly in favor of the formulation and carrying out of a plan that would accomplish a real betterment of stream conditions through treatment of industrial and domestic wastes. We believe that policies could be worked out that would have many beneficial results to the nation at large and would not hurt industry, though it might cause a chorus of anticipated squawks.



Front view of Norcross filter plant



Rear view of Norcross filter plant

Iron Removal Plant Treats 75 G.P.M.

A NEW iron removal plant has been constructed at Norcross, Ga., from plans prepared by Wiedeman and Singleton, Consulting Engineers, Atlanta, Ga. Norcross has a population of 892 and the plant is designed to treat 75 gallons per minute or 100,000 gallons a day.

The water supply is from a 6-inch well, 336 feet deep, drilled in 1926, which supplies about 65 gpm. A typical analysis of the water is as follows: pH, 7.2; CO_2, 15 ppm; alkalinity, 69 ppm; total hardness, 70 ppm; iron, 2.5 to 3.0 ppm; manganese, 0.2 ppm; and H_2S, a trace.

Raw water from the well is pumped to aerators placed over the settling basin. These occupy a space 30 ft. 6 ins. long and 10 feet wide and consist of four Sprayco nozzles mounted over a tray 10 inches deep. The nozzles and tray are enclosed by pine louvres 6 ft. high to prevent the spray from being blown out of the tray.

As the aerated water leaves the aerator tray, it is chlorinated and passed to the mixing channel. As the water enters the mixing channel, soda ash and alum are added. The mixing flume or channel is of the over-and-under baffle type, 29 ft. 6 ins. long, 5 feet deep and 2 feet wide; providing a mixing period of 30 minutes at design flow of 75 gpm. The over and under baffles are ¾-inch pine boards, No. 1, common, with slots beveled 1 inch, and spaced as follows, from the inlet of the mixing channel: 30 baffles spaced 3 inches on centers; 24 baffles, 4 inches on centers; 16 baffles, 6 inches on centers and four baffles spaced 12 inches on centers. This mixing channel is covered with 1-inch subway grating.

The single settling basin is 24 ft. 6 inches long, 10 feet wide and 13 feet overall depth, giving a retention period of about 5 hours. There is also one filter unit, 7 feet long and 5 ft. 6 ins. wide which, at 2 gallons per sq. ft. per minute, provides a capacity of 75 gallons per minute. There is one wash water trough placed in the center of the filter on the long dimension.

The filter has a concrete floor in which is set a center manifold; into the manifold are set 1¼ x 1¼ x 2-inch streamlined copper tees, with one 5/32-inch hole drilled in the side. Into the tees are set seventeen 1¼-inch copper pipe laterals into which 5/32-inch holes are drilled at 8-inch centers on both sides. The holes are drilled just below the center and staggered, to give openings 4 inches on centers on alternate sides of the pipe.

Over the underdrains is placed 23 inches of gravel and 27 inches of sand. The gravel sizes and depths are: 8 ins. passing a 2½-inch screen and retained on a 1-inch screen; 3 ins. passing 1-inch and retained on ½-inch; 3 ins. passing ½ and retained on ¼; 3 inches passing ¼ and retained on ⅛; 3 inches passing ⅛ and retained on 1/12; and 3 inches of torpedo sand having an effective size of 0.8 to 1.2 mm., and uniformity coefficient of 1.7. The 27 inches of sand has an effective size of 0.45 to 0.55 m.m. and a uniformity coefficient not more than 1.2 to 1.5. Not more than 1/10% is finer than 0.2 m.m.; 90% or more is finer than 0.8 m.m.; and all is finer than 1.0 m.m.

A 20,000 gallon clear well is provided to which the filtered water flows. This clear well is so constructed that a baffle guides the flow of the water, so that the drawoff to the distribution system is on the opposite side of the inlet from the filter.

Equipment includes two Syntron chemical feeders—one for alum and one for soda ash; 1 Wallace & Tiernan chlorinator and an International rate controller and loss of head gauge. The chlorinator is so arranged that it can be used for prechlorination or post chlorination but not for both at the same time.

W. M. Dodd is mayor and A. S. Johnson Superintendent of Water Works. The general contractor on the work was the Griffin Construction Co. of Atlanta; the filter equipment was supplied by Bufard, Hall and Smith, also of Atlanta.

Dry feeders and chlorinator at filter plant, Norcross, Ga.

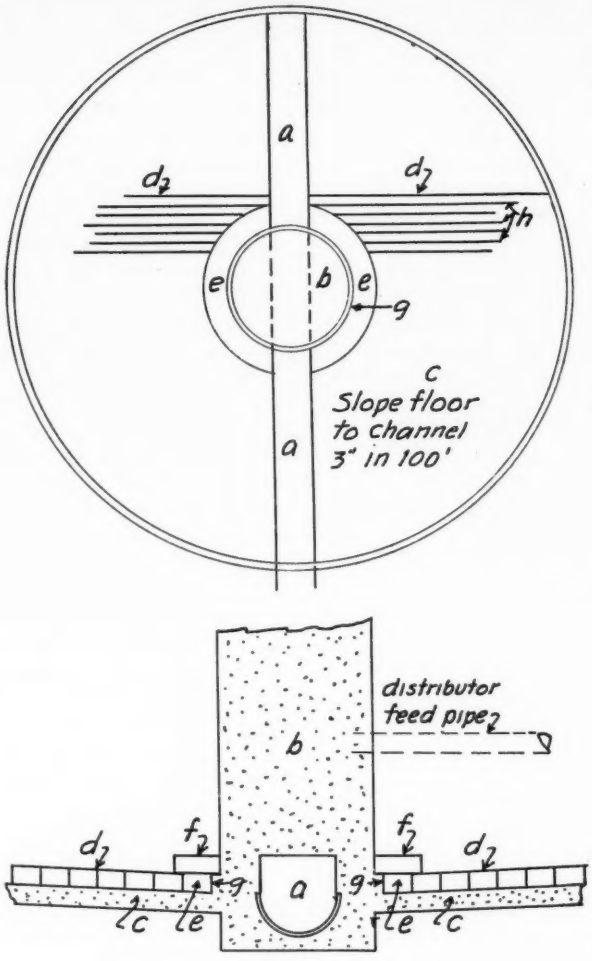


Figure 1

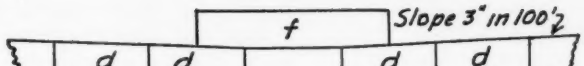


Figure 2

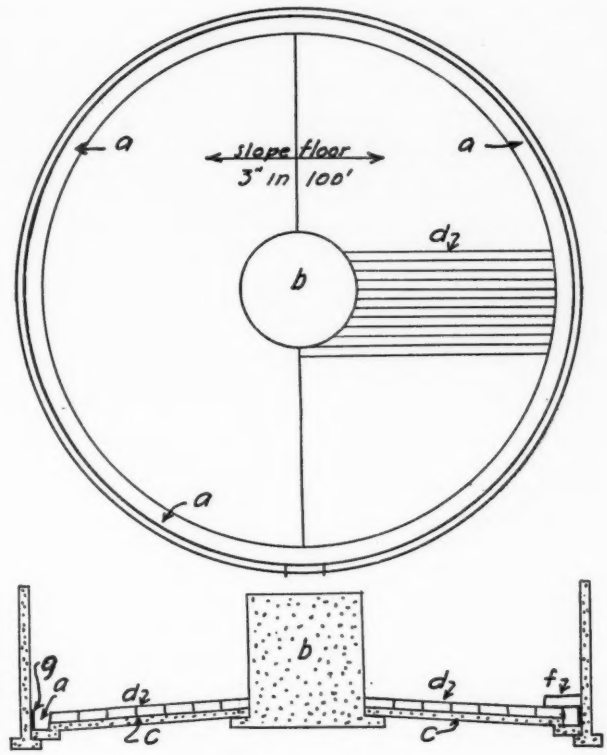


Figure 3

Design Details for Trickling Filter Underdrains and Ventilation

THERE are a number of minor details in the design of underdrainage systems and ventilation for trickling filters, consideration of which results in economy and maximum efficiency in operation. Among the factors to be considered are:

a. Design to obtain uninterrupted and straight lines of drains, without angles or connections, and

b. A method of passing the underdrains under or around the center pier when a rotary distributor is used.

c. Employ a simple design, avoiding a multiplicity of floor slopes with the consequent need for radial drainage and a number of connections; and

d. A filter shape and arrangement that will require the least number of cut or special pieces of underdrain blocks.

e. Provide for ventilation details, such as vents through the filter walls or risers inside of the walls.

A Discussion of General Layout

On circular filters up to about 200 feet in diameter, the simplest and generally best construction is to pass a central drain channel through one diameter of the filter and slope both halves of the filter floor toward this center channel. One method of accomplishing this is shown in Fig. 1, in both plan and cross-section, the latter being on an enlarged scale. In this, *a* represents the channel which is carried through under the center pier *b*, which supports the distributor; *c* is the floor of the filter; *d* represents the underdrain blocks, which are stopped about 12 inches from the center pier to form a channel *e* to carry the flow around the pier. Cover blocks *f* are placed over this channel to prevent the filter stone from filling it. In order to support these cover blocks, a shoulder or ledge *g* about 4 or 6 inches wide must be cast on the center pier.

The effluent collected by the underdrains, represented by *h* in the plan, is thus conveyed around the center pier and to the channel, which is covered with special filter cover blocks, as shown in PUBLIC WORKS for February, 1940, page 36, or by half or channel tile as shown on page 28 of that issue.

With a rectangular filter employing either spray nozzles or a reciprocating type of distributor, the same general method can be employed for units of

moderate size. A center drain channel is constructed and both halves of the filter are sloped uniformly to this channel. In very large units, shapes other than rectangular are sometimes employed and these present special problems; but in installations of moderate size, there is seldom any reason for employing other than the simple rectangular shape. A center channel construction is shown in section in Fig. 2, the letters referring to the same items as in the case of Fig. 1. If preferred, the floor can be sloped from the center line to the sides, and two side drains used instead of one center drain. It is generally preferable to locate such drains inside the wall, rather than outside. If located outside, openings must be placed in the wall at the end of each run of drains—every 12 ins. or so—and this makes reinforcing difficult. If located inside, a shoulder should be cast on the inside of the wall to support the cover blocks, as shown by *g*, Figs. 1 and 3.

Another simple design for a circular filter is shown in Fig. 3. In this the floor is sloped both ways from a diameter and a channel is constructed just inside of the walls of the filter. This eliminates any problem of getting around or through the center pier, but creates several new problems. First, the length of the channel is more than three times as great as that of a single central channel, requiring more cover blocks; construction is somewhat more complicated; more slope is required because of the greater length of the channel (about 1.57 times as much slope will be required); and the footings of the retaining walls will change in elevation, or the channel itself must be designed to provide for this. Ordinarily this will not be a serious matter, since a channel slope of 3 inches will ordinarily be sufficient and the interior footing of the retaining walls can be adjusted for this. It is also possible to carry the underdrains through the wall and have an outside channel, with access to every drain. With a circular filter, where only light vertical reinforcing is required, this will not be difficult if a type of reducer block is passed through the wall to carry the flow to the outside channel. But with a cantilever type wall in which the vertical reinforcement is heavy and the bars are placed only a few inches apart, it is almost impossible to provide openings through the wall that will allow access to the underdrains.

Other Design Details

Supporting the Distributing Pipe.—When using spray nozzles, cast iron pipe is normally used for distributing the sewage to the nozzles. The distance between the lines of pipe will vary, depending on the method used, as by cross lines of small pipe or by connecting the nozzles directly to main lines of pipe. In either case, the method of supporting the pipe is important. There are three commonly used procedures: (a) Placing the pipe on concrete posts 2 to 4 feet high; (b) laying the pipe on the surface of the stone; (c) laying the pipe on the floor or in the stone without supports.

The last method is preferable. There is little if any danger that the stone will settle enough to break or injure the pipe if it is laid in the stone 2 to 4 feet below the surface of the bed; but if breakage or leaks are feared, the pipe can be laid directly on the underdrain blocks. These (see PUBLIC WORKS, April, 1940) have a crushing strength of about 600 pounds per sq. inch and are amply able to support the pipe.

If the pipe is supported on concrete posts, as is often done, these posts should be set on top of the filter blocks. Otherwise the lines of underdrains are blocked by the posts, drainage is interfered with and added cost in placing the floor is incurred.

When the pipes are placed on top of the stone, as was done by Metcalf & Eddy at the Fitchburg, Mass., plant, there is some difficulty in tapping the spray nozzles into the larger pipes.

The simplest solution seems to be to place the pipes 2 to 4 feet beneath the stone surface. Less digging is required to reach the pipe in case repairs are needed. Sewage leaking from joints or breaks passes through enough stone to receive some treatment. In case supports are desired, small upright pipes may be used, resting on the filter floor or the underdrain blocks and clamped at the top to the distributor pipes.

Center Pier Details

When rotary distributors are used, the filter is circular or octagonal with a central pier to support the distributor. As already stated, the best design here is to slope the two halves of the filter floor to a center effluent channel and to run the underdrain lines directly to this center channel in unbroken parallel lines. However, the center pier is in the way of both the center chan-

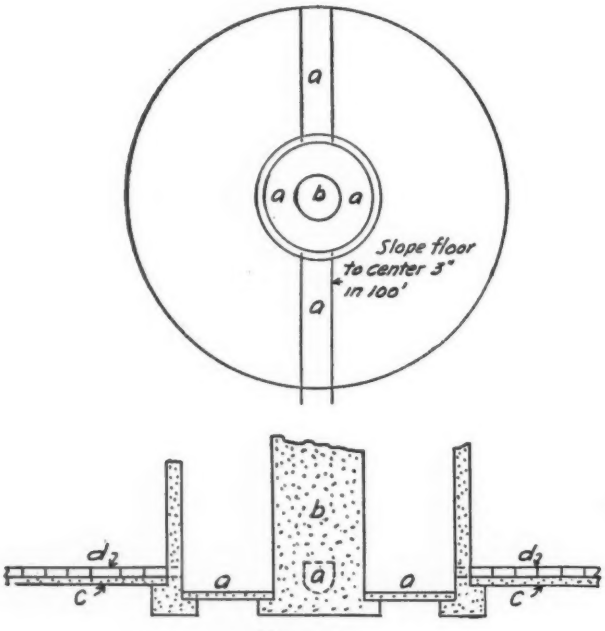


Figure 4

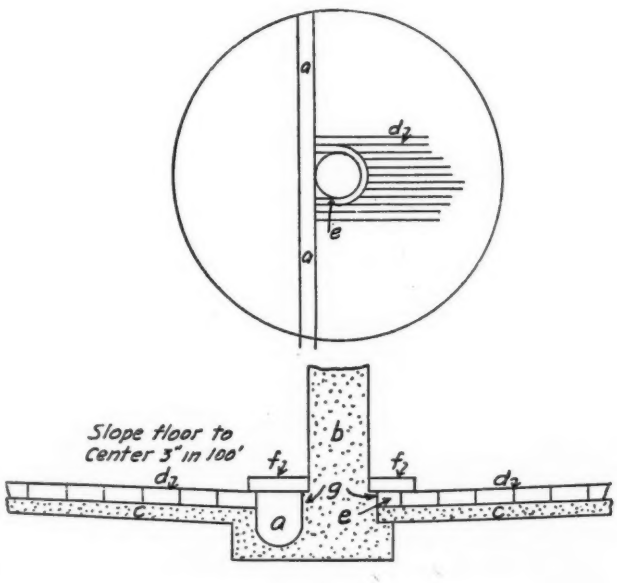


Figure 5

nel and of certain lines of underdrains.

In filters 6 to 8 feet deep, the feed pipe for the rotary distributor may be brought in through the filter stone. If this is done, the center effluent channel may be carried through and under the pier, as shown in Fig. 1. But this does not solve the problem of the underdrains, which, as shown in the plan of Fig. 1, cannot be carried through to the effluent channel. In shallow filters of the Jenks type, the pipe is normally brought under the filter and prevents carrying the effluent channel through the center pier.

The possible methods of handling drainage where center piers are used include the following:

a. Central well around the distributor support with effluent channel passing around the pier. The effluent channel may slope from both ends to this central well and the filter effluent be removed by a pipe; or the channel may have a uniform slope along the entire filter diameter and discharge outside of the filter. The underdrains may pass through the outer wall of the well without much design trouble, since the only pressure is compressive, as on a ring or submerged cylinder, and but little reinforcing is required. This arrangement, shown in Fig. 4, is perhaps the simplest for ordinary designs. If considered necessary to have the underdrains open to inspection, a passage way can be built over the center channel, usually accomplished by using blocks and a half-tile section (see P. W. February, 1940, p. 28).

b. The channel may be offset from the center pier just enough to clear it. This simplifies everything except the problem of the underdrain lines intercepted by the pier. These can best be handled by casting a shoulder on the pier of the same height as the underdrain blocks, stopping the underdrain lines about 8 ins. from the pier, and placing cover blocks over this opening. This arrangement is shown in Fig. 5.

Arrangement for Drainage

Any filter with a diameter or width (if rectangular) of not more than 200 feet should be built with a uniform slope to a drainage channel at or near the center. The use of several floor slopes draining to radial or branched channels is unnecessary and is generally poor design; when using the more efficient underdrain blocks (as compared to channel or half tile), smooth connections between the channels cannot be made and there is extra cost for cutting blocks and for waste. Channel tile underdrains are not as efficient as block-type drains and are also difficult and costly to build up as radial or forked drains, since special connections, as Y's, must be placed at all connections.

A floor slope of 3 ins. in 100 feet is sufficient when using filter blocks laid in straight runs, as the hydraulic properties of the flow channels are excellent if the blocks are laid uniformly and in straight and unbroken lines.

It costs less to build a smooth floor and lay filter blocks than to construct a vaned or corrugated floor and cover the channels with slabs or blocks, and the construction difficulty of obtaining a floor with a smooth surface and with the necessary uniform slope is considerably increased. When a smooth floor has been built, filter blocks can be purchased and properly placed at a total completed cost of about 25 cents a square foot, more or less, depending somewhat on location. The price given can be taken as a fair estimating price. Most block manufacturers furnish necessary supervision and advice for installation.

When a rotary distributor is used, the filter is usually circular, but may be octagonal. When spray nozzles are employed, the filter is nearly always rectangular but is sometimes triangular.

The circular filter is the simplest from the viewpoint of concrete design. Circumferential reinforcing carries most of the load and the walls need not be stable against overturning though they are usually made so. A smaller footing and a thinner wall are possible, saving concrete.

Each line of filter underdrains must be cut to the angle of the wall at the particular point of contact, as shown in Fig. 6, on an exaggerated scale. Underdrain blocks must be mitered or cut to the curve of the outside of the filter and to the curve of the center pier, as shown by *m*, Fig. 6A. Other letters refer to the same items as in Fig. 1. Fig 6B shows an octagonal filter in which points of cutting or mitering of underdrain blocks are indicated by *m*. This mitering or cutting is not a serious objection and not a great deal of wastage ensues with either type of filter, but less with the octagonal. By making the center pier also octagonal, as shown by dotted lines in Fig. 6B, the only cut or mitered blocks required are 45°, and these will fit any place, whereas with the circular filter differing angles of cut are required.

The circular filter with principal reliance on circumferential reinforcing, and with light vertical reinforcing, permits reducing vents to be carried through the wall more readily than does the octagonal type. But if

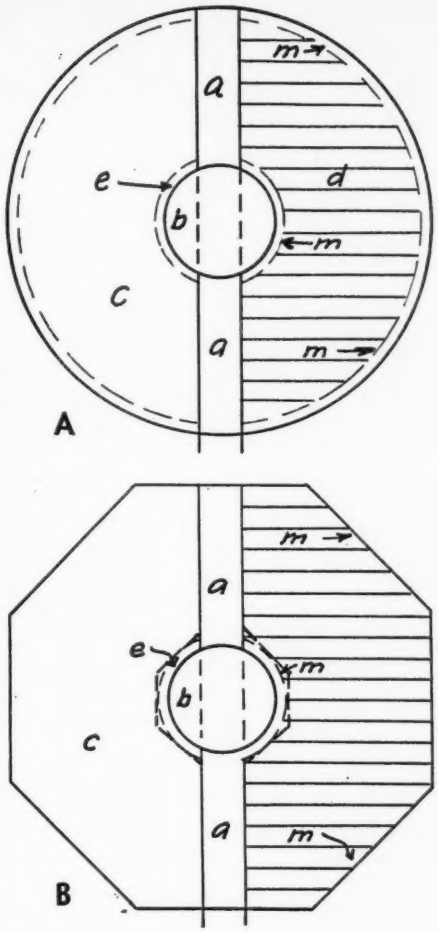


Figure 6

uprights are used for ventilation instead of reducers through the wall, the octagonal filter is simplest. Such reducing vents are shown in Fig. 7, a, b and c.

The octagonal filter is a relatively new design. First used by Jenks in California, it is a feature of the new Liberty plant. It has advantages in appearance; it is easier for WPA workmen to build; the forming is cheaper; construction is simpler; construction joints can be placed at any one of the angles. It requires a little more stone and a little more wall. Thus, an 80-ft. circular filter has a perimeter of 251.33 ft. and an area of 5026.5 ft., whereas a circumscribed octagon has a perimeter of 265.1 feet and an area of 5301.7 feet. Little of this extra area is available for use; nevertheless the reduced cost of this construction may overbalance the greater amount of materials.

The octagonal filter wall must be designed as a retaining wall against overturning, and this necessitates considerable vertical reinforcing. In the case of the rectangular filter, also, the walls must be designed to resist overturning, as retaining walls are designed. In each of these the heavy vertical reinforcing that must be provided will usually prevent carrying

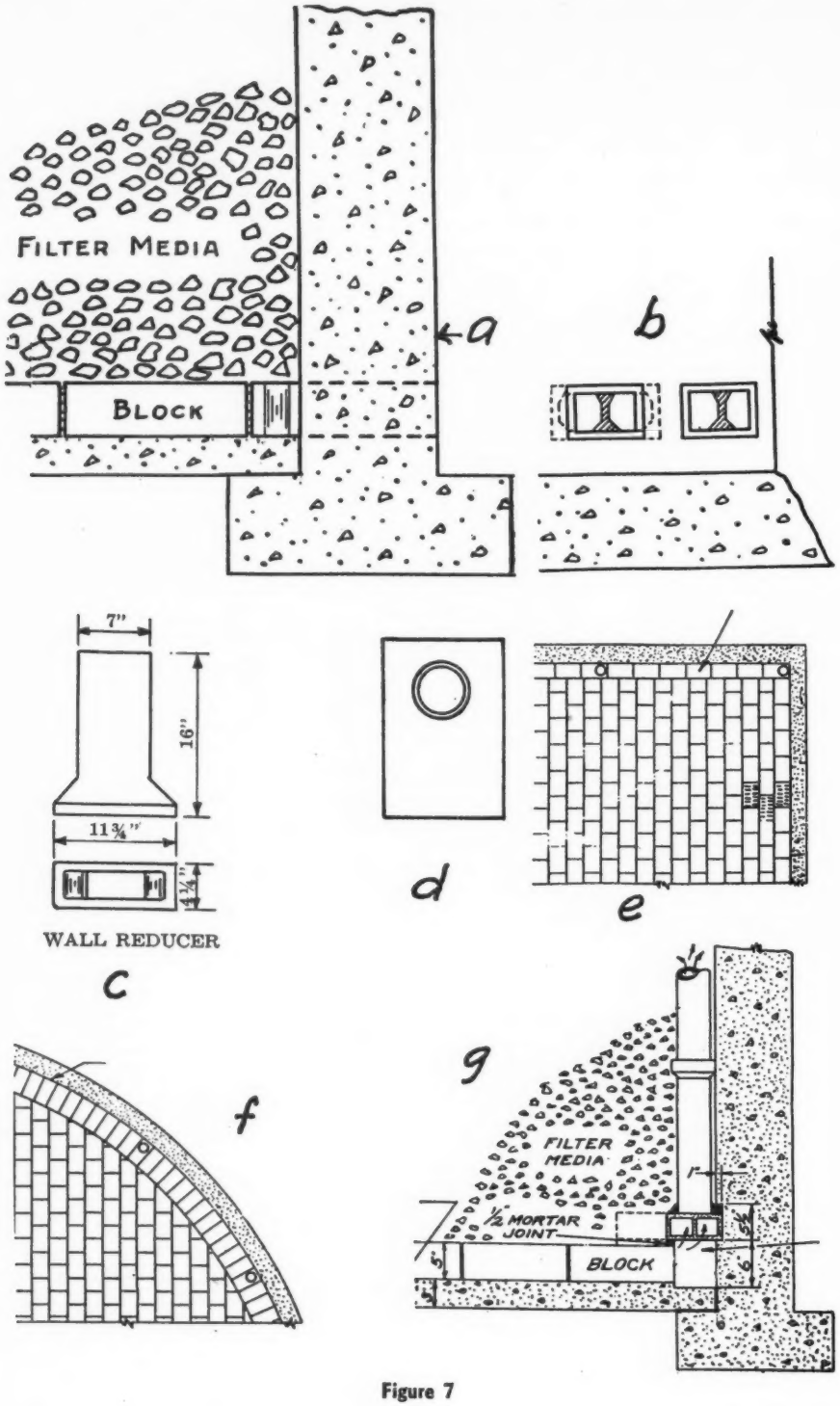


Figure 7

underdrain extensions through the walls, and some of the methods shown hereafter, which avoid this, must be used.

In Fig. 7, which illustrates details of ventilation, *a* and *b* show how the reducing vent is used and *c* shows dimensions of the standard reducer. The use of these permits a clear wall space of about 4¼ ins. in every 11¾ ins. and will normally interfere with reinforcing on other than circular filters, where only light vertical reinforcing is used. Fig. *7g* shows the method of using vertical vent pipes instead of wall reducers, which methods are best on rectangular and octagonal filters. The filter underdrain blocks are stopped about 6 ins. from the wall, or a little more, and covered with a special block, as shown in *g*, or with channel (half) tile. Risers of standard vitrified sewer pipe are placed at intervals around the edge of the filter as shown in *e* for a rectangular and *f* for a circular filter. A cover block with a connection for a riser is shown in *d*.

All of the illustrations in Fig. 7 are taken from manufacturers' catalogs and show standard fittings that are readily available, as well as standard methods of construction. Both standard fittings and standard procedures should be used wherever possible on account of economy.

The riser vents shown in *7e* and *7f* should not be placed too close together. While State regulations must govern, it is recommended that spacing of about 20 ft. be used unless strong reasons exist for either closer or wider spacing.

This article has been prepared to answer some of the many questions arising from the interest shown in the trickling filter articles published in PUBLIC WORKS in February, March, April and May, 1940. In addition, the editors of PUBLIC WORKS will be glad to supply further detailed information and they invite correspondence whenever they can be of assistance.

Sewer Infiltration at Fort Worth

In designing sanitary sewers for Fort Worth, Texas, infiltration plays a very important part; in fact, it is usually so great that the city cannot afford to furnish pipe large enough to carry the largest flows, but provides a size that is expected to flow under pressure at times. Finances often are the determining factor in what is finally built.

The amount of infiltration varies not only with intensity of rainfall, but also with height of water table and the condition of the ground surface (such as cracks caused by extended drought). The same amount of rainfall that would flood a system one day might cause no inconvenience another.

Infiltration may be due to several causes. If a sewer is laid in a rock cut, this serves as a channel to collect ground water, which then flows along the pipe and enters any faulty joints, unused Y's or leaky house connections. House connections often run along the side of a house under the roof eaves, where the ground gets more than the average amount of rain; and these connections often contain faulty joints. Or water may reach the connections from gravel subdrainage under and around basements.

Another source is the uncovered areaway drain and other traps so located that rain water that does not actually fall on them is picked up by them. An example is a catch basin in a garage toward which the driveway slopes. These should not be allowed to connect to a sanitary sewer.

The above is part of a paper read before the Texas A. & M. College Station School by R. W. Andrews, Assistant City Engineer of Fort Worth.

Remote Control of Youngstown's Pumping Plants

By ROBERT I. WILLIAMS

THE water department of Youngstown, Ohio, operates five pumping plants, four of them by remote and automatic control. At the fifth plant is an arrangement for keeping constant check on the operation of all the pumps and the water elevations in the several standpipes and storage tanks.

One plant pumps the city's supply from Meander lake through two 36" lines 5½ miles to a 30 mg underground reservoir at the west boundary of the city. Here a second pumping plant raises into a 500,000 gallon standpipe the supply for the west side of the city.

From the reservoir water flows by gravity 3½ miles to the north side pumps, 5½ miles to the east side pumps, and 3 miles to the south side pumps. These booster pumps raise the water into three standpipes, that at the north side having a capacity of 2,250,000 gal., that at the east side 1,400,000 gal., and that at the south side is a 3,000,000 gal. elevated tank.

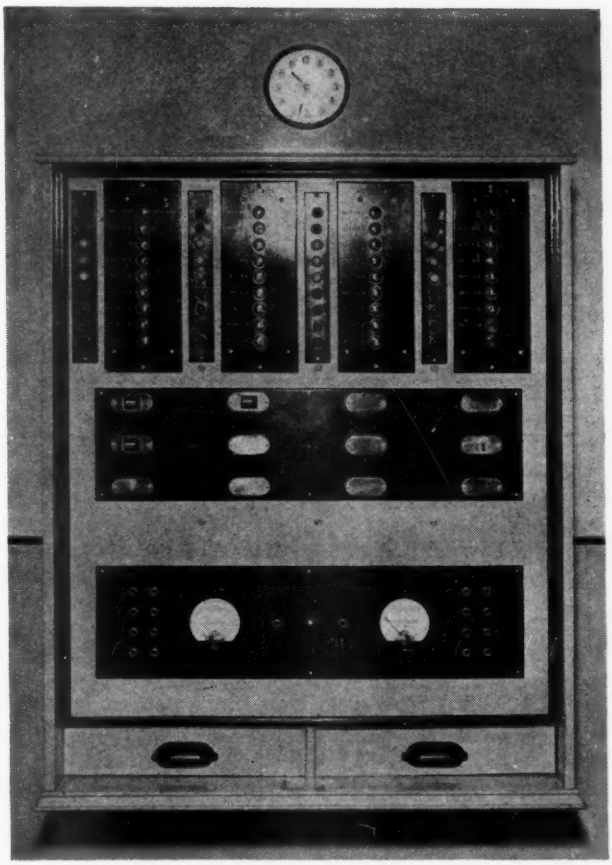
The district served by the south side pumps and tank is a heavily populated residential section, and the pumping station here is the heart of the system, and the only one under full time direct control, the others being automatically operated. It was desirable, however, to keep constant check on the operation of the pumps and the water elevations in the several tanks. This is done by a device contrived and made by David C. McFarlin, then electrical engineer in the department, consisting of a transmitter at each of the pumping stations and standpipes and a receiving apparatus at the south side plant.

The operation of the receiving apparatus depends on the piezo-electric properties of rochelle salt (sodium potassium tartrate) crystals. These crystals, one for each standpipe, are rectangular in shape and are known as bender type. Two sections of crystal are covered with aluminum foil and cemented together so that they oppose each other when an electromotive force or mechanical force is applied. Each crystal is securely clamped at one end, while the other end is free. The free end has cemented to it a bronze clip which comes in contact with a bronze arm anchored at one end.

The bronze arm is tuned to a certain frequency transmitted from a contact disc at one of the various standpipes, the tuning being done by adding weight at the end of the arm, the lower frequencies requiring the most weight on the arm. On the end of each bronze arm is a small target which swings behind a window about one inch in diameter and serves as a visual signal to the operator.

The transmitter at each standpipe consists of a synchronous motor of one-sixth horse-power running at 1,800 r.p.m. driving a bakelite disc with 9 groups of contacts imbedded in the bakelite, each representing a rise or fall of 2½ ft. from the one next to it.

Each one of the crystals in the central station board is tuned to one group of contacts in the transmitter disc and the proper crystal and arm will vibrate when the corresponding group of contacts is cut onto the telephone line. The contact switch at the top of the tank is controlled by a small float which rises and falls with the water. The contact wheel on the standpipe consists of a circular piece of bakelite with a bronze ring mounted on the outer circumference. This bronze ring is cut at intervals to represent each 2½ ft. of fall or rise of the water, covering a total distance of 20 feet below the overflow; it being decided that at no time during normal operation should the level fall more than 20 feet below the overflow. (However, the entire tank could be calibrated every three inches, if that were necessary, by designing the contact wheel to suit.) If the level of the water should reach 20 feet below the overflow and the pumps have not started, as indicated by the fact that crystals showing pump operation were not vibrating, it is necessary to go to the remote pumping station and start the pumps by hand.



Meter board used to check tank elevations and pump operations. Each of the four large vertical panels at the top of the board shows conditions at a particular storage. The long horizontal panel in the center contains gauges to show the pumpage into the tanks, and the meters on the lower horizontal panel are for checking the crystals in the receiving set, and the transmission line.

A single telephone wire operating at ground potential is all that is necessary for the system, and the current used is so low that the average meter will not measure it. The crystals operate without any dependence on commercial power but the transmitter does depend on the commercial power lines for operation.

As a result of the arrangement it is necessary to check the booster stations in person only once daily (except in cases of emergency).

An Engineering Approach

By JOSEPH BARNETT

Senior Highway Engineer, Public Roads Administration

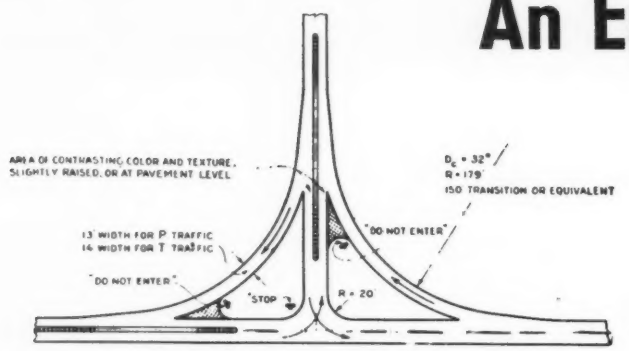

AREA OF CONTRASTING COLOR AND TEXTURE, SLIGHTLY RAISED, OR AT PAVEMENT LEVEL
D_c = 32°
R = 179'
150 TRANSITION OR EQUIVALENT
13' WIDTH FOR P TRAFFIC
14' WIDTH FOR T TRAFFIC
"DO NOT ENTER"
"DO NOT ENTER"
"STOP"
R = 20

Fig. 8. One-way separate turning lanes.

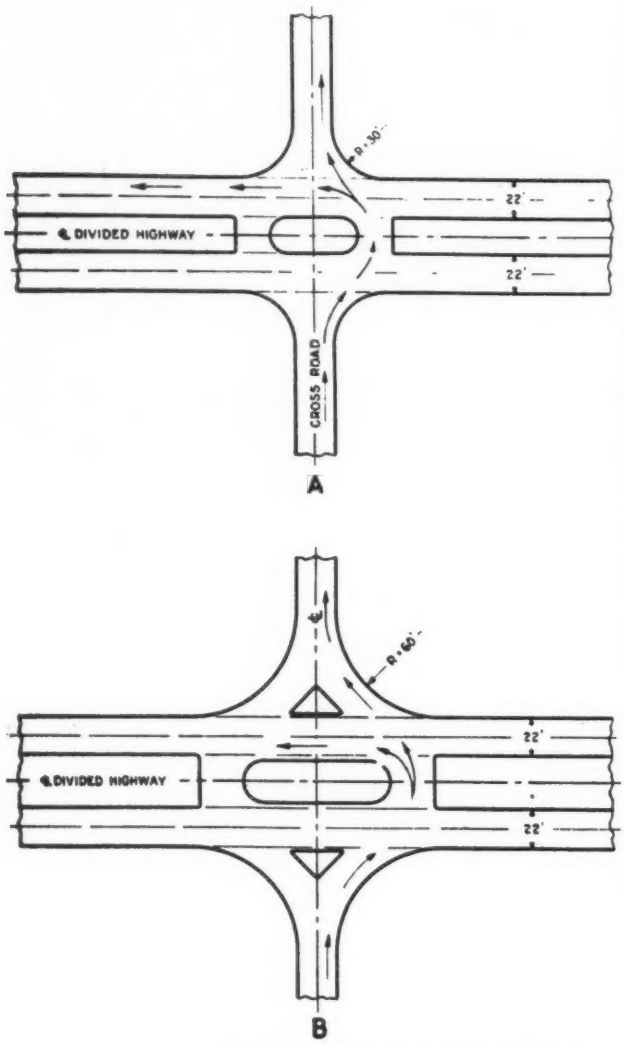
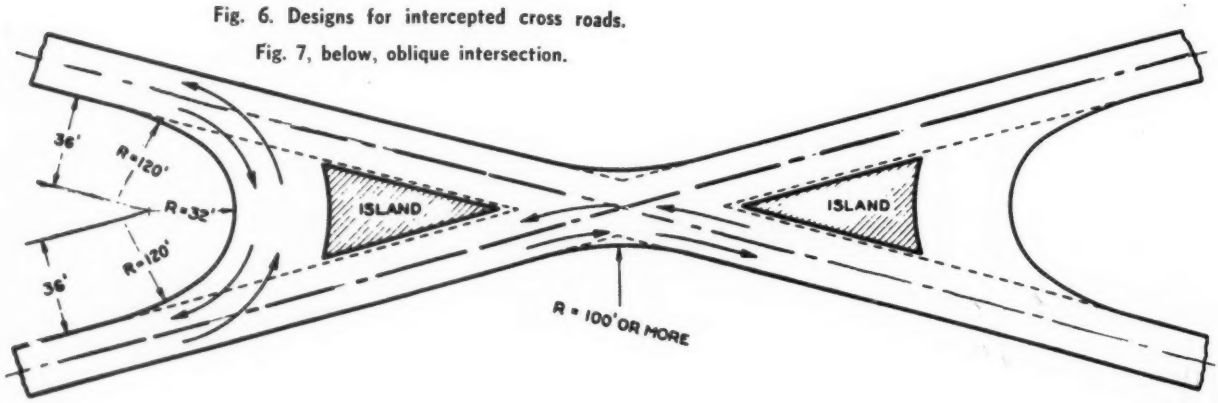


Fig. 6. Designs for intercepted cross roads.

Fig. 7, below, oblique intersection.



INTERSECTION design is essentially a problem in geometric highway design, which deals with the visible dimensions of a highway: width, alinement, curvature, sight distance, etc., and with those factors which affect traffic behavior. Geometric design is also important when funds are limited. At such time a high-type pavement, curbs and other essentially structural items may be deferred but sufficient right of way should be obtained at each intersection so as to permit its proper ultimate development. At no other point on a highway is adjacent private property more likely to be built upon or to increase in value.

In geometric highway design the "loads" or design factors are the traffic density, the type of traffic, and the assumed design speed. In the design of intersections the numbers of vehicles making each turn as well as the densities of through traffic and the type of traffic should be known. A classification of roads divides traffic into three types, "P" to denote passenger vehicles exclusively or combined with trucks which travel about the same speed as passenger vehicles; "T" to denote traffic with a sufficient percentage of large trucks which impede the flow of passenger vehicles; and "M" to denote mixed traffic or passenger vehicles combined with trucks which impede the flow of passenger vehicles occasionally. In addition, consideration must be given to the turning and other physical characteristics of the vehicle, which, in a general sense, determine the design of the area used for turning; and to the speed of travel.

Vehicle Characteristics.—For minimum design it may be assumed that vehicles will slow down to 20 m.p.h. or less so that the design of the intersection may be determined entirely from the physical characteristics of the vehicles—the turning radius, the wheel base, the width of vehicle, and the dimensions of the overhangs. In order to determine these characteristics, turning radii were plotted against wheel base of vehicles and from this diagram vehicles with severe characteristics were chosen. These are shown in figure 1.

to the Design of Highway Intersections

Highway intersections are increasingly important, but cross-over structures are limited by money available to only a few localities. Here Mr. Barnett presents basic data on intersection design.

Minimum Designs for Edge of Pavement.—The paths of the vehicles when making the sharpest right turn have been plotted and various designs for the edge of pavement to fit the path of the inner rear wheel have been made. Such designs for passenger vehicles are shown in figure 2 (which is shown on page 24). A simple radius for the edge of pavement does not fit the minimum path of the inner rear wheel as closely as a sharper radius curve offset from the tangents produced and connected to them with transitions or larger radius curves, resulting in a three-centered curve. The figure shows minimum designs for the edge of pavement which will enable practically all slow moving vehicles to make right turns without encroaching on adjacent lanes. Minimum all-paved intersections with the edges of pavement designed in accordance with the above are shown in figure 3. Vehicles at such intersections are enabled to turn left without difficulty. Where parking lanes are provided and parking adjacent to the corner prohibited, shorter radii for the edge of pavement, as shown in figure 3D, enable the same types of turns to be made.

Design of Median Strips at Intersections.—The method of designing the edge of pavement for right turns has been applied to the design of intersections for divided highways with median strips. These intersections will operate satisfactorily if the median strips at the intersections are wide enough and the openings long enough to enable vehicles to cross and turn without impeding the operation of high speed through traffic. The median strip may be any width between intersections but at intersections at grade they should be carefully designed to accommodate the various expected movements.

A vehicle turning left onto a divided highway should be able to cross traffic in one direction, rest in the median area clear of opposing and divided highway traffic, and then turn left onto the the inside lane of the divided highway. Designs of this character for passenger vehicles and trucks are shown in figure 4. They result in a minimum width of median strip of 25 feet for passenger vehicles and 43 feet for trucks. A compromise width of 32 feet will enable a design truck or bus to left turn by entering the outer lane of a 4-lane divided highway. The openings between semicircular ends of median strips should be at least 50 feet long for passenger vehicles and 78 feet for trucks. Openings of this character provide adequately also for U-turning and left turning from the divided highway.

Where the desirable width of median strip cannot be obtained, median widths of 19 feet for passenger vehicles and 30 feet for trucks and busses may be considered. These widths of median strip combined with lengths of opening at least 56 feet and 80 feet respectively provide full protection for crossing vehicles,

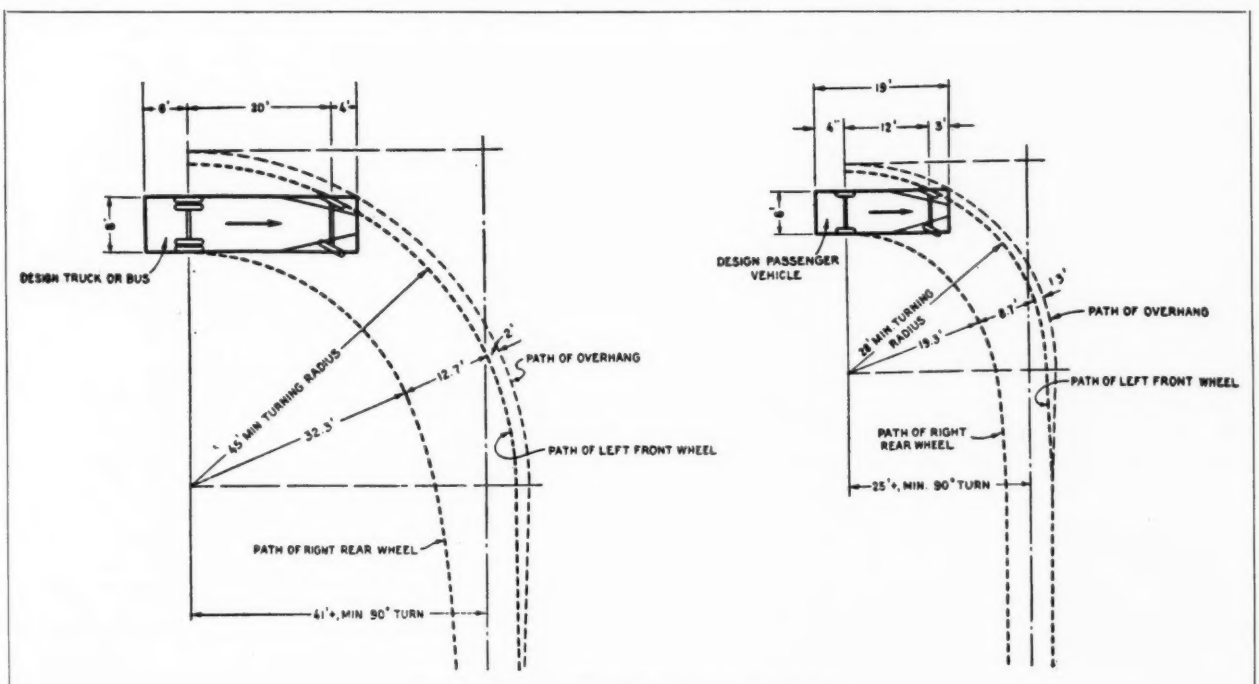
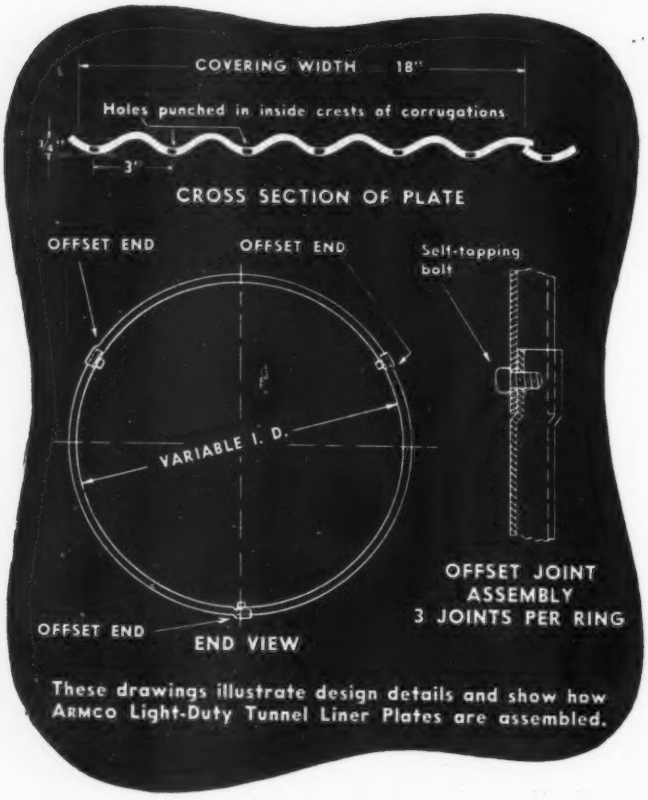


Fig. 1. Turning radii plotted against wheel base.


COVERING WIDTH 18"
Holes punched in inside crests of corrugations
3"
CROSS SECTION OF PLATE
OFFSET END
OFFSET END
Self-tapping bolt
VARIABLE I. D.
OFFSET JOINT ASSEMBLY 3 JOINTS PER RING
OFFSET END
END VIEW
These drawings illustrate design details and show how ARMCO Light-Duty Tunnel Liner Plates are assembled.

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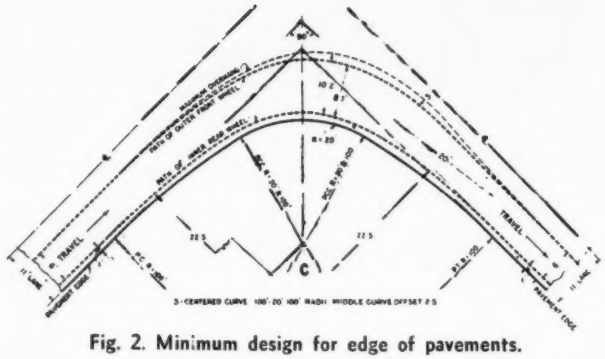

Fig. 2. Minimum design for edge of pavements.

but vehicles which turn left onto the divided highway find themselves encroaching on the lanes of opposing cross road traffic when they reach a position in the median area clear of through traffic on the divided highway.

Unnecessarily long openings are undesirable because they encourage promiscuous wandering and require unnecessary and unusual pavement, discourage pedestrians crossing the divided highway from using the median strip as a refuge, and frequently defeat the purpose for which the opening is made. To avoid unnecessarily long openings in median strips, the ends of the median strip may be elongated instead of semicircular. Where this is not desirable, the median strip may be channelized to provide refuge for turning vehicles somewhat as shown in figure 5. Other methods for expediting through and turning traffic at divided highways are being tried. Variations of one general idea are shown in figure 6. A vehicle crossing or turning left from the cross road is confronted with the intercepting island or section of median strip and is required to swing to the right and stop. The angle is not unduly sharp and the distance which must be traversed is little longer than the width of the one-way road. Left-turning vehicles can swing wide either before or after making the left turn in the space provided for maneuvering or stopping clear of through traffic lanes.

Oblique-angle Intersections.—A crossing at an oblique angle results in two acute-angle curves and

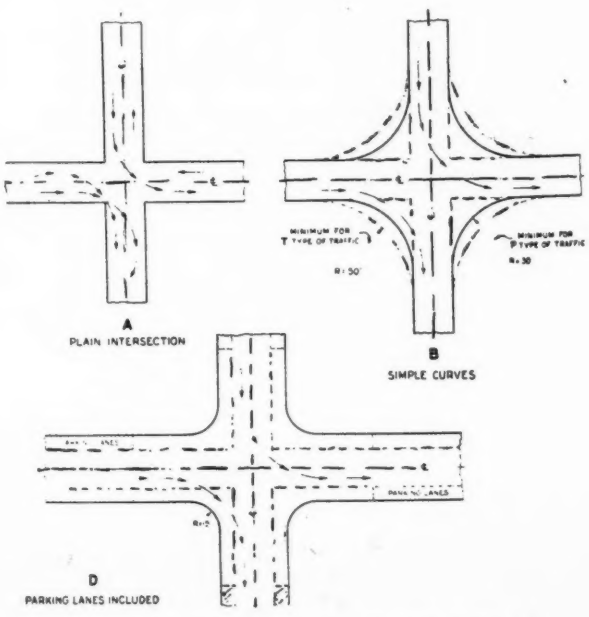

Fig. 3. All-paved intersections at right angles.

Latest News on the Washington National Airport—

24 International TD-18's are Speeding it to Completion!

Above: The International TD-18 Diesels turn, mix, and dry the fill material. They also distribute and re-distribute it around the airport and into the runway bases. An unusual rock formation from the river bed makes it tough on tracks, but the TD-18's are standing the punishment in good shape.

AMERICA'S largest airport and terminal, at Gravelly Point, Va., serving the nation's capital, is now being rushed to completion with the aid of 24 International TD-18 Diesel TracTracTors. These powerful crawlers have taken over this tremendous earth-moving job as a result of the outstanding performance of one of these units which went on the job a year ago.

When the new TD-18 hit the market early last year, the demand far exceeded the supply. As soon as the Northern Virginia Construction Co., Alexandria, managed to get one, they put it to work on the Washington Airport. Right from the start, the TD-18 became the most popular tractor on the field. Everyone wanted to use it. Unqualified statements made by those who got it, labeled the TD-18 as the *best tractor on the field regardless of size.*

With all these men *the reputation of* this great tractor *was made.* It was natural, then, for 12 more TD-18's to get the call in February. Today there's a total of 24, owned by the Northern Virginia Construction Co.; L. B. Smith, Harrisburg; and the Capital Excavating Co., Highway Engineering Co., and Morauer and Harzell, Washington. In addition, there are 2 International I-40 wheel-type tractors on the job.

The International TD-18 Diesel *had to be plenty good on the Washington Airport*—as on *every* job, because it's been under the severest scrutiny. And its three new smaller brothers are carrying on the good work. See the International industrial power dealer or Company branch near you about the four International Diesel TracTracTors.

Runways are rough-formed by the TD-18's which also mix the surface with plows, cultivators, and harrows.

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INTERNATIONAL Industrial Power

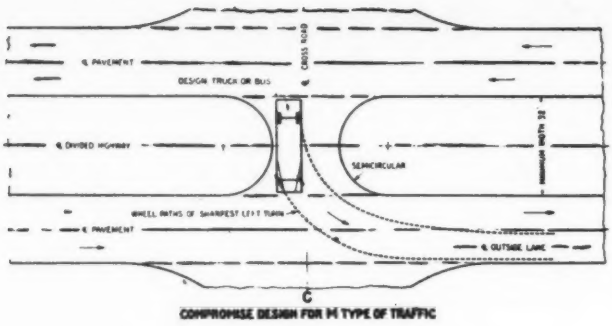

Fig. 4. Median strips at intersections.

two obtuse-angle curves, minimum designs for which have been developed by plotting the sharpest paths of the design vehicles and fitting curves or combinations of curves to the paths of the inner rear wheels. These are illustrated in figure 7.

Somewhere in the range of 40- to 60-degree angles it becomes desirable to introduce an island into the design for both types of traffic. The all-paved intersection provides more space than is reasonably necessary, encouraging hazardous promiscuous wandering on the part of drivers of turning vehicles. All necessary maneuvering space is provided, with less pavement area, by the use of islands. It is desirable to locate the islands about two feet outside the pavement edges extended, providing an extra two feet of lane width between the normal center line and the island, particularly at the entrance end of the lane. It also seems reasonable to omit islands unless they are at least 5 feet across. Islands should be only slightly raised above the pavement level so that they can be crossed if necessary and should be composed of a surfacing material differing from the pavement in texture and color.

Separate Turning Lanes.—It frequently is desirable to expedite turning movements by providing means for making turns at appreciable speeds, say greater than 20 miles per hour. This may be done by increasing the radius of edge of pavement or by providing separate lanes for turning traffic. The principles used for designing highway curves apply to curves at intersections except that somewhat greater side friction factors are permissible because drivers expect a conscious sense of turning and full superelevation cannot be provided where the radius of the turn is relatively small.

A two-lane width for one-way turning lanes ordinarily is provided to insure that the one-way road will not be blocked in case of a vehicle breakdown, but a width of two lanes at the exit end of a turning lane is dangerous because of the possibility of two vehicles entering a through route at the same time. It is desirable that this practice be discouraged by narrowing the exit end of a one-way two-lane turning road to the width of one lane requiring turning traffic to enter the through road in single file.

Separate turning lanes frequently are provided at T-type intersections to permit turning at appreciable speed, as shown in figure 8 in which the separate turning lanes are designed for a speed of 50 miles per hour. A "T" intersection with a single separate turning lane is shown in figure 11. It serves admirably where traffic on the through road is dense compared to traffic on the terminating road. The separate lane takes turning traffic out of the way of through traffic and all traffic entering the throad road is stopped in a position where the through road is easily observed. There is the possibility that drivers, in spite of appropriate signs, will use the turning lane instead of proceeding to the intersection proper to turn left onto the through road. This dangerous practice should be discouraged by constructing a median strip or wide center line opposite the exit of the separate turning lane as shown. It may be no more than a foot or two wide, but should contrast in color and surface texture with the adjoining pavement surface. It may be raised slightly but should be easily mountable.

Flared Intersections.—A flared intersection is one in which the number of traffic lanes or the pavement width near the intersection exceeds the number of lanes or the width of the normal section of highway. It provides extra leeway for all maneuvering at the intersection, and increases the capacity through the intersection. Flared intersections at the junction of two-lane highways carrying light to medium traffic, or multilane highways with relatively light traffic, probably could be controlled by signs only. With heavier traffic conditions some form of traffic control is a necessary part of the flared intersection.

The capacity of a non-flared intersection is less than 50 per cent of the combined capacities of the intersecting roads. Theoretically highways may be flared at intersections sufficiently to increase the capacity of the intersection to a much higher percentage. Practically, however, the addition of more than one or at most two extra traffic lanes on each side cannot be justified, as each additional lane requires through vehicles to cross another lane of cross traffic both on approaching and leaving the intersection. Where the density of turning traffic is appreciable it may be advisable to further add a lane for the exclusive use of right-turning traffic.

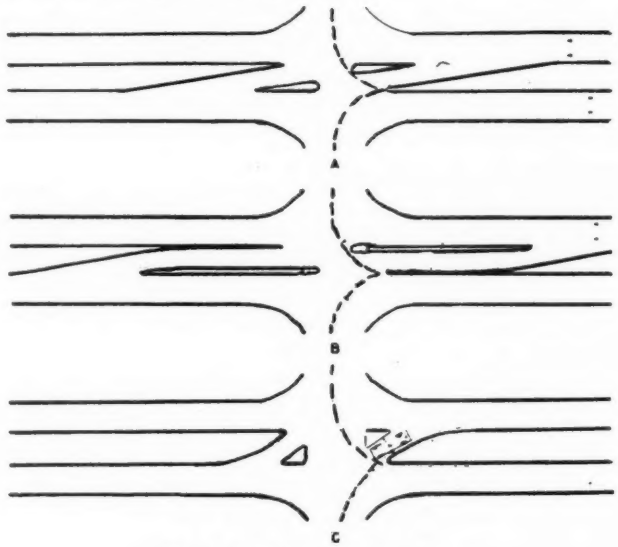

Fig. 5. Channelized median strips.

In some respects flared intersection design is undesirable. The wide pavement at the intersection may become hazardous by inviting high speed, promiscuous wandering, and cutting corners. Left turns must be made against a greater number of opposing traffic streams. Cross traffic is required to traverse a relatively long distance. The wide throat makes crossing by pedestrians hazardous unless refuge islands are provided which may be a hindrance and hazard to vehicular traffic. The additional area of pavement must be paid for and must be maintained.

Islands and Channels.—The use of increased radii for the design of edge of pavement at intersections,

the use of flared intersections and speed-change lanes, and adequate provision for right turns at acute angled intersections all tend to increase the area of the intersection and, therefore, maneuvering space. When more than two roads intersect, the area of the intersection is further increased. In addition to increased cost of construction and maintenance, large intersection areas tend to create hazards which defeat the purposes for which the increased area is provided. This is due to the fact that whenever greater space than is reasonably necessary for the execution of any maneuver is provided the probability of improper maneuvers is increased.

The hazard involved in large intersection areas may be reduced by omitting pavement from unused areas or, in other words, by introducing conspicuous islands to channelize traffic.

Sight Distance at Intersections.—With reference to sight distance, intersections at grade not controlled by traffic lights may be divided into those at which traffic on one road is controlled by STOP signs and those at which it is not. The latter may be further subdivided into those at which one road is designated a preference road and those at which no preference is indicated.

Where no preference is indicated at an intersection it should be so designed that the operator of an approaching vehicle on either road has an unobstructed view of both the whole intersection and a length of the intersecting highway for a distance from the intersection sufficient to enable him to stop his vehicle, if necessary, before reaching the intersection. Assuming 2 seconds for the total of perception and brake reaction time and a coefficient of friction of 0.4 for stopping at an intersection, the equation for the stopping distance is:

$d = 2.93\ V + .083\ V^2$ in which d = stopping distance in feet, and v = speed in miles per hour.

This results in stopping distances varying from 160 feet for a speed of 30 m.p.h. to 610 feet for a speed of 70 m.p.h. There should be no obstructions in the triangle bounded by the intersecting roads and a line between the points whose distances from the intersection equal the stopping distances. If the triangle is obstructed the speed on one or both roads approaching the intersection should be reduced by appropriate signs or traffic on one road stopped at the intersection.

Where the density of traffic using an intersection is light the intersection may be operated without speed or STOP control even though the sight distance is somewhat less than the stopping distance. Collision can be avoided if the sight distance is sufficient to enable a driver to slow down before reaching the intersection. It is necessary, however, that the intersection and the intersecting road be open to view at a distance at least equal to that traversed during perception and brake reaction time and say another second or a total of 3 seconds. This distance in feet equals 4.4 V (V in m.p.h.) resulting in distances varying from 130 feet for a speed of 30 m.p.h. to 220 feet for 50 m.p.h. Intersections with these sight distances are hazardous because of possible confusion between drivers and because of the possibility of closely spaced vehicles on one road. Such distances, therefore, should be considered absolute minima.

Acknowledgment: This is a portion of a paper by Mr. Barnett before the 1940 meeting of the Association of Highway Officials of the North Atlantic States.

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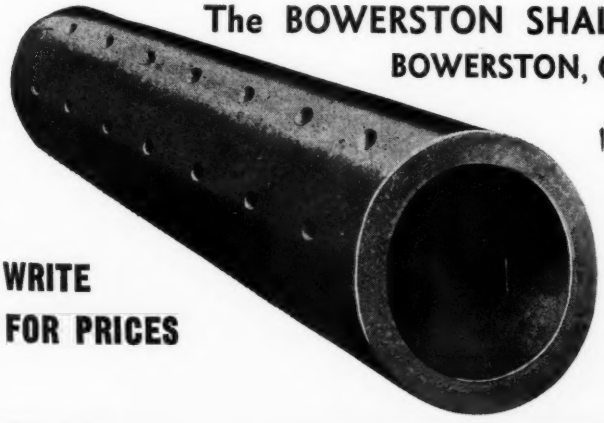


WRITE FOR PRICES

Five Advantages of Properly Designed Office Forms

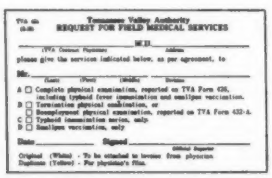
By JOHN F. PIERCE

Consultant in Office Management; Formerly, Director, Office Service; Department, Tennessee Valley Authority

ONE of the unobserved "wastes" in any office is that of the unnecessary clerical operations performed to record useless information on poorly designed forms. On the other hand, the proper use of forms will expedite the office work, reduce the number of clerical errors, remove the uncertainty of understanding that accompanies verbal instructions, provide written records, and conserve the time of the administrator and other employees.

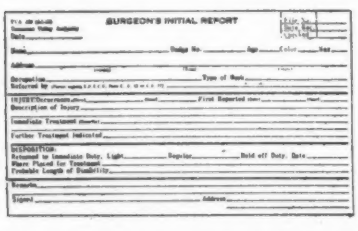
These advantages, however, can be quickly lost because of the admission of new factors, such as the introduction of another form which may affect the existing procedures, the lack of the necessity for continuing to record the information, and changes in the methods of recording the data, for example, from pencil to typewriter. In order to make sure that the continued use of the forms is worthwhile, it is advisable to conduct an "audit," or examination, of them periodically, and at least annually.

Employees should not be allowed to design any form that they want to use, nor be granted permission to have a form printed without considering how it will fit into the existing forms and procedures. Unless this review is made, there is bound to be additional clerical labor used unnecessarily. In addition, there will be an increased expenditure of public funds for its printing, and additional labor and equipment required for the storing and the filing of the new form. This additional office expense can be greatly reduced by requiring the submission of all proposed forms, and all forms that are to be reprinted, to one person for review and coordination prior to any action being taken with them.



Tennessee Valley Authority
REQUEST FOR FIELD MEDICAL SERVICES

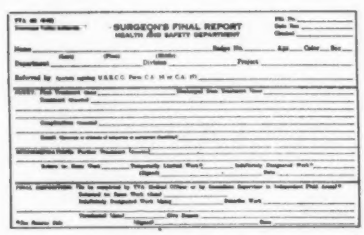
Prepare in Duplicate. Original and Duplicate to Physician who completes and forwards Original copy with invoice to Construction Medical Division, Chattanooga. Duplicate retained by physician.



SURGEON'S INITIAL REPORT

This section to be completed by the official superior before mailing it to the physician.

Send one blank form to physician who completes and forwards to Construction Medical Service Division, Chattanooga.



SURGEON'S FINAL REPORT
HEALTH AND SAFETY DEPARTMENT

This section to be completed by the official superior before mailing it to the physician.

Send one blank form to physician who completes "Injury" and "Recommendations" and returns form to Immediate Supervisor. Immediate Supervisor then completes "Final Disposition" and forwards to Chief, Construction Medical Service Division, Chattanooga.

Studying Office Forms

The first function of the coordinator is that of making a collection of all forms in use in his organization. Some of these forms will originate in other departments, and some, because of legislation, will originate outside of the political unit, such as the forms required by the Federal Government. In order to obtain a complete picture of the clerical labor necessary in the preparation and in the handling of these forms by the personnel of the organization, it is necessary that a study be made of their use and routing.

Keeping in mind that the purpose of a form is to record essential information, the coordinator questions the need for the form. It is not unusual to find that the original intent of the form no longer exists though no one has suggested its discontinuance. The only positive method for determining the use to which the form is being placed is to question every user of it. Find out what they do with each item on it. In some instances it will be found that they transfer the information, or part of it, to another form, or report, and in which case, it will be necessary to follow the trail until that particular item is no longer copied. One must determine how a form is being used and if its use is a justifiable one.

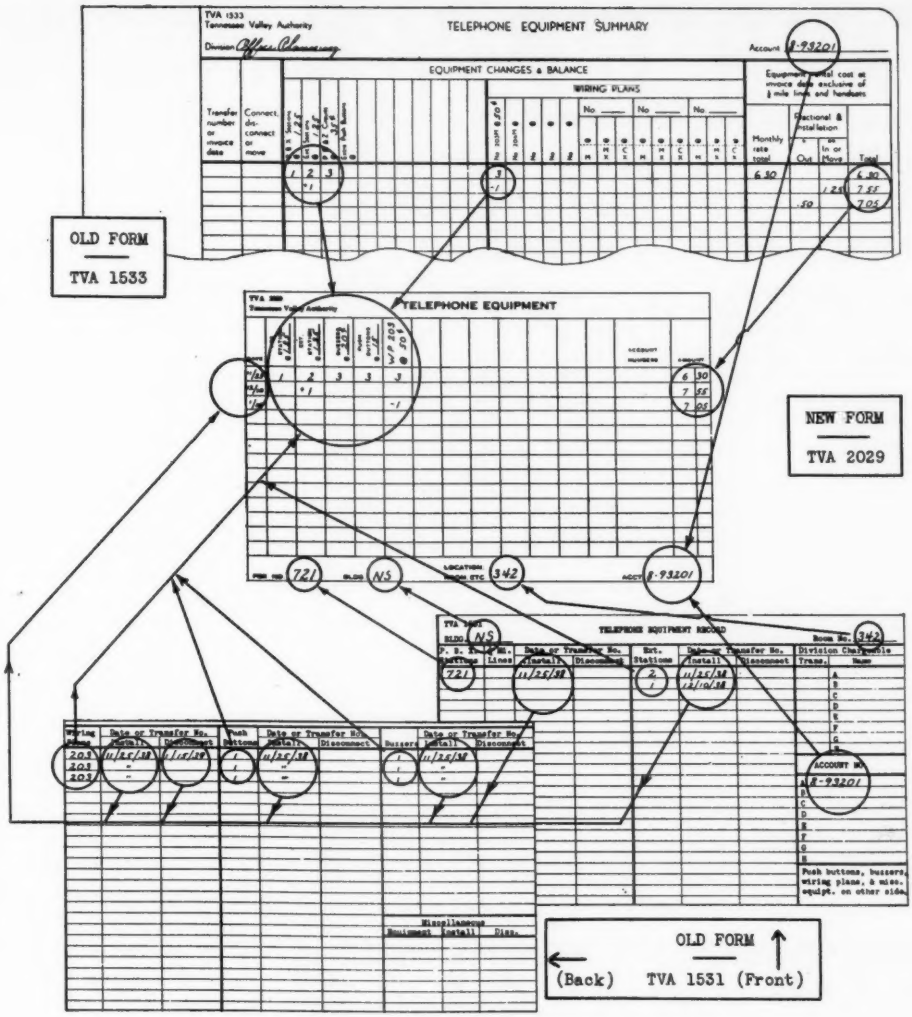
Sometimes the coordinator will be told that the data are being used for "information." At this point in the audit of forms it will be necessary that he exercise judgment in determining the necessity for the particular individual to have the "information" in order to carry out his assigned duties. If the "information" is not made available, will the carrying out of the functions of the organization be made more difficult or impossible?

The purpose of every blank space on the form should be questioned. When examining a completed form, do not be surprised to find that there are some spaces that are not filled in. This will indicate that either the particular information requested is not required, or that someone is negligent in recording essential data. There must have been a reason for requesting the information when the form was first designed and the coordinator should try to determine it. The knowledge of the original reason for incorporating it in the form should enable one to determine its present use and value.

In addition to determining the necessity for each

item on the form, it is essential that a concurrent study be made of the valid use of each copy of the form. Who receives the copies? What does he do with the information? How are these copies filed, and for what period of time? For each form, and copy of form, there is expended human effort in recording the information, in transporting, handling, and filing the form; and supplies and equipment, such as paper, carbon paper, and filing cabinets, are required. Every motion made by the personnel and every piece of paper that can be eliminated will aid in the reduction of operating costs.

After eliminating all items on the form that cannot be justified, a thorough investigation of the remaining items should be made. Where does the information come from that is to be recorded, and is it available in the same manner that is requested on the form? In many instances it will be found that original information is needed to complete the form. It may surprise some coordinators to find how many times the same information is recopied from one form to another form. Can another form, if it is properly routed or slightly redesigned, and which has similar information, be used in place of the form now being studied? Is the information being entered of such a nature that clerical time could be saved if a part of it were printed on the form at the time of the printing? For example, how many times will "1940," the dollar sign, or some other unit of measurement such as "miles," have to be written, or typed, during the current year? Wherever possible, all repetitive words, signs, figures, etc. should be printed on the form.

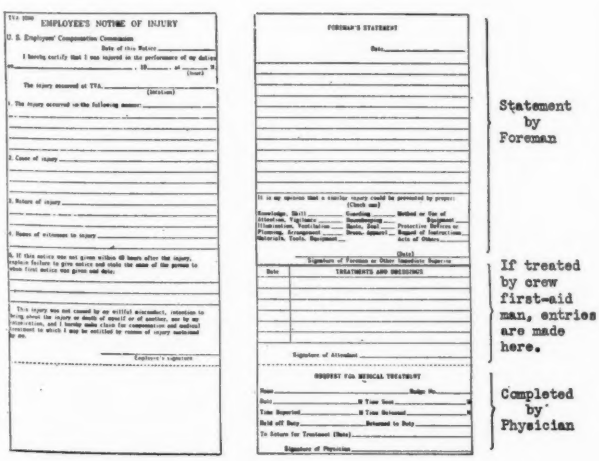


One form does the job of three

Redesigning the Form

Having answered these and similar questions satisfactorily, and justifying the need for the form, the coordinator is now ready to redesign the form. There are many questions that have to be answered before a form can be correctly designed, such as: how is the information to be recorded; how is the form to be used and filed; will it be used internally, externally, or both; is it to be a permanent record, or can it be destroyed immediately, or within a few years; what is the most economical method of printing; and is it to be a "master" to be used in a reproduction process?

How is the information to be recorded? By pencil, pen, typewriter, mechanical accounting machines, duplicating or addressing machines? It is essential that the exact method be determined. For example, shall ruled lines be provided? The answer depends upon how this information is to be recorded. If a typewriter, mechanical accounting machine, duplicating or addressing machine is to be used, it is not necessary to provide ruled lines. Not only will the printing costs be saved, but the time of the operator in filling out the form will be reduced, as she will not have to adjust her machine to the lines. When ruled lines are necessary, space them six to the inch for single spacing of the typewriter, and three to the inch for double spac-


EMPLOYEE'S NOTICE OF INJURY
FOREMAN'S STATEMENT
TREATMENTS AND DIRECTIONS
REQUEST FOR MEDICAL TREATMENT
Statement by Foreman
If treated by crew first-aid man, entries are made here.
Completed by Physician

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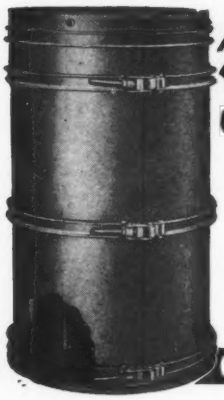

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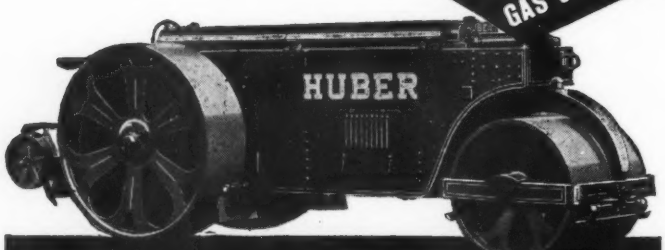

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ing. If the pen or the pencil is to be used, the spacing should be the same throughout.

In providing for the recording of data in columnar form, the width of the column should be sufficient to allow for the typing, or the writing, of the largest description, or the longest number. If the typewriter has Elite (small) type the carriage will travel one inch for every 12 strokes, and if it has Pica (large) type the carriage will travel one inch for every 10 strokes. The vertical space, or column length, should be sufficient to allow for the average number of entries that can be expected to be made.

Is this form one of the many required in a procedure? One of the principles of good form design is that of avoiding the necessity for the use of other forms in conjunction with the one under consideration. Unless one is careful, it will be found that the form cannot be used by itself and will require the use of another form.

The items on the form should be arranged in the order in which they are to be used. If the information is to be taken from another form, then the arrangements of the items should be the same on both forms. If not, then, valuable time is wasted, and errors are frequent, when the grouping of the items on one form differs from that of another.

Each form should have a name and a number for reference and filing. The name should be the one that is commonly referred to in the organization. For example, an order on the supply house or storeroom is referred to as a "Stores" or "Materials" requisition. Avoid the use of too many words in describing the form and limit the description to those words necessary for identification. Sometimes a form is known by more than one name, in which case it will be necessary to adopt the one which best describes its functions.

There are several methods for numbering the forms, one of which is to assign the numbers in uninterrupted succession. The objection to this method is that, at a later date, there will be numbers that are not in use because of the forms having been discontinued. This is not a serious objection, however, as the master file will include a copy of every form issued, whether it be active or inactive, in numerical order.

Another method is to assign the numbers by series. For example, each department would be assigned a number, such as 100 for the Controller's department, and the forms would be numbered in sequence for this series. The first form would be numbered 101, the second 102, etc. The 200 group might be assigned to the Public Works Department, etc.

In some offices the Dewey decimal system is used. A definite number is assigned to each department, such as 1 for the Public Works Department, and every form issued for this department would be numbered in sequence, such as 1.1, 1.2, 1.3, etc.

Irrespective of the system of numbering, no number should be used a second time, as it will create confusion in the minds of the users.

Costs and Economies

How much will it cost to put the form into use? To arrive at the total cost the coordinator should make an estimate of: (1), the labor required to fill out the form, (2), the equipment required to use and to file the form, (3), the warehousing of the form, and (4), the printing of the form. In arriving at the justification for the use of the form, the anticipated results should be measured in terms of the estimated costs.

Economies can be effected by making more than one copy of the form at a time, by eliminating and ab-

breviating entries, and by eliminating writing by providing for the use of check marks.

Instructions should be printed on each form showing its routing, the office or individual to receive the form, and pertinent information that will enable the clerk to fill it out intelligently.

In determining the size of the form, consideration must be given to the size which can, without waste, be cut from standard size sheets, which measure 17 inches by 22 inches or 17 inches by 28 inches.

Before deciding definitely upon the size, the form should be checked with the envelopes to be used, if the form is to be mailed; with the filing equipment, if it is to be filed; with the mechanical equipment, if it is to be used in mechanical operations; and with the binder, if it is to be filed in a binder.

In one office, it was found that the economy effected by preparing the office memorandum form on paper cut 8½ inches by 5½ inches was lost in the filing process. The time required to locate the paper cut to this size was longer than that required to locate a letter in the file. This was due to the fact that the upper edge of the smaller sized sheet was lower in the folder than that of the letter. It was also noticed that there were more errors in locating the smaller sized sheets, because of the tendency of the file clerk to overlook them when searching for the material.

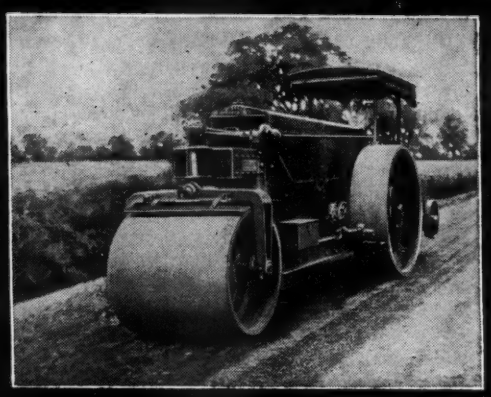
What weight of paper shall be used? One of the factors affecting this question is the period of time that the form will have to be kept. In some instances, it will be found that official papers cannot be destroyed without legislative action and in which case it will be necessary to use a good grade of paper. The best grade of paper should be used for books of original entry, such as are used by the accounting staff; notebooks used in the engineering department; and similar records, as they have a historical value. On the other hand, forms that have a limited life, such as the routing slip, the stores requisition, etc., can be printed on a much cheaper grade of paper.

The treatment that the form is expected to receive is another factor in determining the weight of paper to be used. What is the estimated number of times that it will be removed from the files, how many people will handle it, will it always be used in a flat position? Will it be subjected to handling which may result in bent corners and carelessly being pulled away from the binder posts, and thereby tearing? Will it be mailed?

How is the form to be printed? Many of the forms are today printed on office reproduction equipment at a lower cost than that charged by outside printers. This equipment is the stencil duplicator, the gelatine and the spirit duplicator, the offset or lithographic press, the blueprinting machine, etc.

To use the stencil duplicator, the form is drawn on a wax, protein, or celluose stencil with a stylus. By a photographic process, it is possible to transfer a form prepared on tracing cloth to a stencil. The stencil is attached to the drum of the duplicating machine which is rotated by hand or mechanically. The ink is pressed through the stencil to the paper.

To use the gelatin process, the form is drawn on a special paper by using a hectograph pencil or carbon paper. The copy is transferred to a gelatin sheet, from which it is transferred to the paper. The spirit, or fluid duplicator, or sometimes referred to as the direct process, requires that the copy be prepared on a master sheet, a paper backed by hectograph carbon. The master sheet is placed on a rotary-type duplicator, and, by means of chemicals, the copy is transferred to the paper.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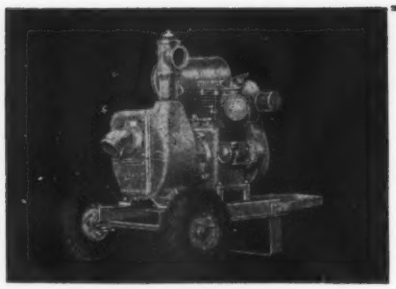

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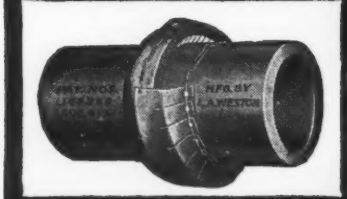

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The lithographic, or offset process consists of photographing the copy and transferring the image from the negative to the metal plate. The plate is attached to a highspeed press and the copy is transferred to the paper by printing. This process is also known as the planograph method. In addition to the metal plate, there is a lighter plate upon which the form can be directly drawn.

In other instances, it will be necessary to have the printing done "outside," and as a result of competitive bidding. In this case it will be necessary to prepare complete specifications for each form covering such items as size; weight; grade and color of paper; color of ink; punched, scored, or perforated; numbered; type face; quantity; packaging; single pads or sets of predetermined numbers; book binding, etc. Bids should be received showing composition costs, printing costs, and paper costs. If there is a possibility of ordering additional printing later, it is advisable for the purchaser to own the composition and thereby save this cost. Where the centralized purchasing system is used, it is possible to purchase the paper cheaper than the price quoted by the printer, especially where all the paper requirements are consolidated.

There are definite disadvantages to having the printing done outside, which are reflected in the cost. For example, the printer will have to include all his costs in one job, and the purchasing department is subjected to additional expense every time new bids are required.

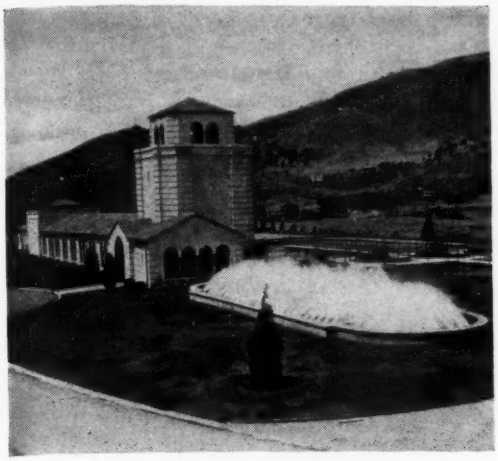
If the office duplicating equipment is to be used, a small quantity can be printed at one time. The stencil, the metal plate, or the "master" for the fluid machine may be used several times, this being a distinct advantage in printing forms in small lots. In some organizations, the printing of the forms is considered a "fill-in" job for the shop and is done during the slack periods. This reduces the number of "peaks and valleys" and helps to maintain a more even flow of work in the shop.

If the printing is to be done outside, an analysis should be made of the quantity used since the last printing, the quantity ordered, and the quantity required to make a manufacturing order. There is always the temptation to order more than the estimated requirements because of the lower unit cost; and the excess is either thrown away, or made into scratch pads at a later date.

A record, in duplicate, should be kept of each form, preferably in an envelope, which will contain a sample of the form, the specifications for printing, suggestions for improvement, the historical records of the number printed, the date of the printing and the cost. This record should be filed numerically and a similar record filed by originating departments.

Cows Defeat Dust-Laying Project

"In a recent endeavor on the part of a road board to allay the dust on a gravel road beyond Tarlton, South Africa, salt was strewn over it. It was thought that the salt would collect the moisture in the atmosphere and prevent dust from rising in the wake of fast-moving vehicles. The experiment worked quite well until cattle grazing in the vicinity discovered that eight miles of road had become a salt lick. The information seems to have spread with great rapidity, as very soon cattle in the neighborhood started to lick the ground, with the result that before long their tongues had created potholes, the salt was taken up, and an interesting experiment was spoiled."—*Roads and Road Construction (London).*



Upper San Leandro filter plant, Oakland, Calif.

The Waterworks Digest

Abstracts of the main features of all important articles dealing with waterworks and water purification that appeared in the previous month's periodicals.

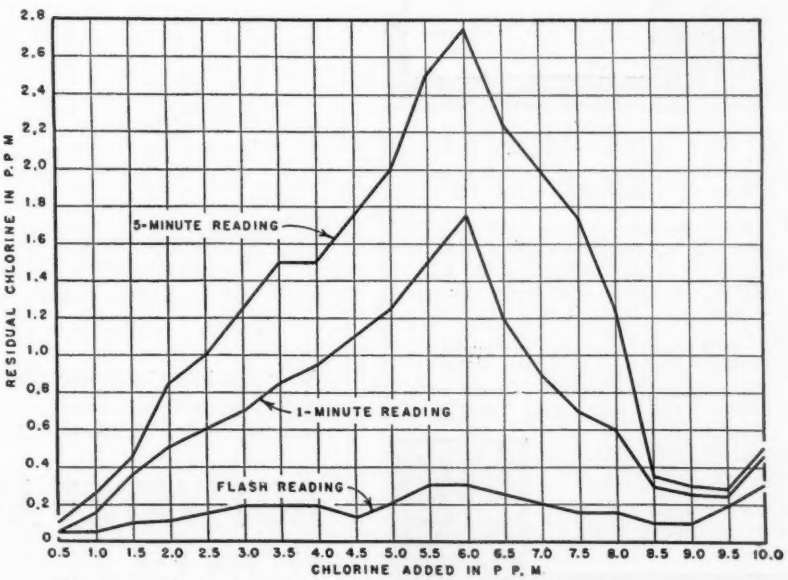
HOW TO FIND ORIGINAL ARTICLES. Key letter at end of each digest refers to name of publication listed in bibliography at end of this section. Numeral indicates title of article.

Water Spreading At Moose Jaw, Saskatchewan

Moose Jaw is constructing works for obtaining a water supply from South Saskatchewan river about 100 miles away. An infiltration gallery 500 ft. long along the river bank collects the water, which is lifted against a head of 380 ft. through 3800 ft. of 24″ pipe and discharged into an open canal 68 miles long with a fall of 175 ft., fenced the entire length, which discharges it onto a 50-acre saturation area, from which it is withdrawn by well points. The top 2 ft. of soil was removed over the saturation area, down to a stratum of sand 20 to 30 ft. deep. A 10″ c.i. header pipe 3800 ft. long was laid 6 ft. below the surface and 192 20-ft. well points connected to it, spaced 15 to 30 ft. apart, calculated to deliver 3 mgd, which will be pumped to the city through 20 miles of 18″ main, 15 miles of which is steel and 5 miles cast iron. The project is estimated to cost $700,000.[J20]

Break-Point Control Methods

The simplest means of break-point chlorine control, for many waters at least, is the Laux method, which takes advantage of the difference in speed of color development by orthotolidin. (See A111). The unreliability of orthotolidin for the control of residual chlorine in finished water resulted in the substitution of the iodimetric method at Indianapolis, Ind. While more cumbersome, it is more accurate and may be used to show active and inactive chlorine. A sample at the left of the break-point shows a much lower chlorine content when titrated without the addition of acid than when acid is present, while at the right of the break point the two are nearly the same. Therefore in plant control a comparison is made of alkaline and acid titrations of each sample. In case of doubt, heat the sample to 43° C for 10 min. before adding the reagents; if no residual chlorine remains, the break-point is close to the dosage employed; if acidification releases no additional chlorine after the alkaline titration, the break-point has been passed; if no chlorine is released without acid but is released with acid, the break-point has not been reached.[G26]



Chlorine residuals after 2-hour contact at freezing point, January 4, 1940

Flash Reading for Break-Point Chlorination

In developing a procedure for using break-point chlorination at Anderson, Ind., difficulty was found in devising a method of determining promptly and accurately whether too little or too much chlorine was being added. After some months of investigation it was learned that orthotolidin color development reaches its maximum reading much more slowly when the dosage is below break-point chlorination than when it is above, and this fact was used for developing the flash reading method. This consists of taking a "flash" or 10-second reading and watching the color development thereafter by minutes. If there is little difference between the flash and 1-minute readings, and the color development for the next five minutes is slow, then the break-point chlorination has been reached or exceeded. If, however, there is a big jump from the flash reading to the 1-minute reading, then break-point chlorination has not been reached. Samples are collected from the end of the mixing tank every 2 hrs., and allowed to stand 30 min. An effort is being made to develop a more rapid procedure based upon tests made at once on pump samples taken hourly; it seems that instantaneous color indicates that break-point chlorination has been reached or exceeded, and that pump samples can be used for plant control by carrying higher residuals than would be satisfactory at the outlet of the mixing tank.

Where break-point chlorination makes car-load-lot purchases practicable but ordinary prechlorination does not, the former may cost little more than the latter. Anderson paid 7½ cts a pound for chlorine in less than carload lots, but only 2¼ cts in ton containers; also it found it necessary to use less activated carbon.[A111]

Maintaining Meter Accuracy Is Economcal

Elgin, Ill., found that, of 181 open-gear ⅝ inch meters 26 yrs. in service, 78% failed to record flows of ¼ gpm, 51% were dead at ½ gpm, and 26% at 1 gpm; and 20% of the consumption was included in these rates. Repairing these cost $805 for new parts (all were given oil-enclosed gears), after which they recorded for billing $600 a year formerly not recorded. The writer gives a large part of the credit to the oil-enclosed gears. After repairing, the meters recorded 96.75% at ¼ gpm flow. Also, he found that the higher the total registration per quarter, the more and faster the accuracies dropped. Greater accuracy brought to light leaks, mostly in toilets, averaging $4.30 per account per quarter; the average toilet leak was at the rate of 1/3 gpm, and 70% of the toilets in the city were leaking. The city now requires that, on ¼ gpm flows, new meters register 98% and repaired meters 95%; or, if using the original measuring chamber, repaired ⅝ and ¾ inch meters must register 92% and 1" meters 90%, and should not fall off more than 2% for 8 or 10 yrs. if the water has about 15 grains of hardness. Repairing meters in one year raised the revenue $7,760 and repairing leaks discovered appreciably reduced pumping costs.[F65]

Water Rate Schedules

There is an astounding variation in water rates throughout the country. The average charge per 100 cu. ft. in 11 of the largest cities varies from 5.1 cts in Chicago to 25.8 cts in San Francisco. Cleveland charges twice as much as Chicago, although both use lake water; San Francisco twice as much as Los Angeles, although both use long-distance supplies; Pittsburgh twice as much as St. Louis, although both use and purify river water. Changes in rates, especially increases, are loaded with political dynamite and superintendents fear to make them, but they are the one point of water works management and operation wherein there is the greatest need of improvement, standardization and equalization.[A102]

As to Cleveland (see above), that city furnishes free water to schools, charitable institutions, hospitals, libraries, cemeteries and all municipal departments, and it is estimated that this adds $1.80 a year to the water bill of the average consumer, or over $400,000 a year. Free water promotes waste by those receiving it, and there is no more justification for it than for free electric power or any other service.[A103]

Aqua Ammonia For Chloramination

Anhydrous ammonia cakes in storage, which increases labor costs and presents feeding difficulties. Aqua ammonia (29.4% solution of ammonia gas in water) has been used at Atlanta, Atlantic City, and Washington, D. C. Washington expects to use about 90,000 lb. of aqua ammonia this year, costing 5 cts per pound of ammonia; anhydrous ammonia costs 15.5 cts a pound. In addition to saving over 50% in cost, there will be no refrigeration troubles; feeding can be regulated more easily allowing minute or large doses to be maintained without fluctuation; and it will be easier to arrange feeding schedules, and opera-

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tors will not be required to handle heavy tanks. At Washington's Dalecardia plant, since Jan. 1, 1940, aqua-ammonia has been used in both pre- and post-application. It has been obtained in 110-gal-drums costing 2.25 cts. a pound, equivalent to 7.5 cts on the anhydrous basis. It is diluted with water to 15% NH_3 and fed just prior to the chlorine in pre-treatment, but in post-treatment both are fed at the same point.[G28]

Bibliography of Waterworks Literature

The articles in each magazine are numbered continuously throughout the year, beginning with our January issue.

c. Indicates construction article; *n*, note or short article; *p*, paper before a society (complete or abstract); *t*, technical article.

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99. The Water Board as a Factor in Good Management. By H. S. Nollen. Pp. 899-910.
100. The Public Service Commission and Plant Management. By R. A. Nixon. Pp. 912-922.
101. The Engineer Looks at Management. By R. E. McDonnell. Pp. 923-932.
102. Management of Municipally Owned Water Works on a Business Basis. By R. F. MacDowell. Pp. 933-944.
103. An Engineer's View of Public Service After Four Years' Experience. By F. O. Wallene. Pp. 945-951.
104. The Kind of Boss I Like. By L. Semple. Pp. 952-957.
105. As You Like It.—In Public Relations. By J. C. Mellett. Pp. 958-960.
106. Water Rate Structure in American Cities. By E. W. Moke. Pp. 961-986.
107. Organizing to Prevent Fires. By P. Bugbee. Pp. 987-992.
108. Water Works' View of the Use of Public Water Supplies for Private Fire Protection. By R. Newsom. Pp. 993-1000.
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110. Recreational Use of Watersheds. Symposium. Pp. 1009-1026.
111. Break-Point Chlorination at Anderson, Ind. By P. C. Laux. Pp. 1027-1037.
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28. Sabotage and Water Service. Pp. 50-54.
29. Delaware Aqueduct: Controlling the Flow. Pp. 73-77.
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F *Water Works Engineering*
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60. Installation, Repair and Maintenances Methods in Charleston, S. C. By N. N. Wolpert. Pp. 858-862.
61. Plant Changes Save 27% in Operation. By L. Harvey. Pp. 864-865.
62. Distribution Valve Records. Pp. 887-888.

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63. Changes in the Filter Systems at Denver. By O. J. Ripple. Pp. 914-916.
64. Construction of Reservoirs for Bridgeport, Conn. By T. F. Magner. Pp. 916, 927.
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25. Softening Plant of the Metropolitan Water District of Southern California. By C. P. Hoover, J. M. Montgomery and W. W. Aultman. Pp. 293-298.
26. p. Super-Chlorination. By C. K. Calvert. Pp. 299-303.
27. The Cost of Mains. By D. R. Taylor. P. 304.
28. Aqua Ammonia for Chloramination. By C. J. Lauter. Pp. 306-308.

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20. River Water Supply for Moose Jaw, Sask. By A. W. E. Fawkes. Pp. 40-41, 74.
21. Light Fines Make Meters Effective and Popular. Pp. 46-47.
22. Servicing and Testing Meters. By M. S. Dutton. Pp. 70-72.
23. Water Rates and Service Charges. Pp. 75-77.

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10. Algae Control. By J. B. Baty. Pp. 20, 48.

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11. Design and Construction of Outdoor Swimming Pools. By E. H. Darling. Pp. 7-9, 52.

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25. New Filter Plant Replaces Old at Thomaston, Ga. P. 12.
26. Let's Take a Water Sample. By F. C. Roberts, Jr. Pp. 17-18.
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5. Theory of Steel Paints and Recent Developments in Wood Preservation. By E. Bizzozero. Pp. 88-94.

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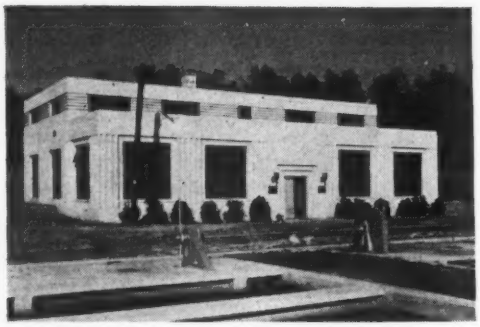


Atlanta, Ga., Sewage Treatment Plant

The Sewerage Digest

A Digest of the Sewerage Literature of the Month giving the main features of all the important articles published.

HOW TO FIND ORIGINAL ARTICLES. Key letter at end of each digest refers to name of publication listed in bibliography at end of this section. Numeral indicates title of article.

Experimental Plants at Chicago

At the West Side Works, Chicago, experiments have been conducted with the Halvorson high-rate trickling filter, Jenks two-stage biofilter, chemical precipitation, magnetic filters, short aeration period activated sludge, and the Guggenheim process. "The most striking fact is the superiority of the short-period activated sludge effluent over all others. The chemically treated effluent was considerably inferior, even if supplemented by final mechanical filtration. High-rate biological filters gave better effluents than chemical precipitation and about equal to chemical precipitation plus filters, but decidedly inferior to activated sludge."[X31]

Pipe Pushing In England

In laying a 6″ pipe 62 ft. long across a canal and 3′8″ below its bed, in England, a method of pushing (instead of cofferdamming and trenching) was employed that differed in some respects from American practice. A 3″ hole was first made all the way through, then enlarged to 7″ by pulling an "enlarging head" through it, and then a 10″ enlarging head was pushed through. The soil was hard blue clay, and the enlarging heads compacted this so solidly that there was no danger of a collapse of the hole. The 6″ steel pipe was then drawn through the hole. It is found that the ground around the pipe gradually expands and grips it. The hole was bored from a 4′3″ pit with a hydraulic pushing machine, using oil and a high-pressure hand-operated pump. The first hole was driven the 62 ft. in 1¾ hrs., the 7″ enlarging head attached and drawn back to the pit in 2 hrs.; then the 10″ head attached and pushed through to the far end, and the steel pipe attached and drawn back in 4 hrs. The pressure exerted by the machine reached 1½ tons per sq. in. on the gauge (size of cylinder not stated). Boring operation cost about 33 pounds (about $150, and required 1½ 8½-hour days.[D21]

Sewer Servicing In New York City

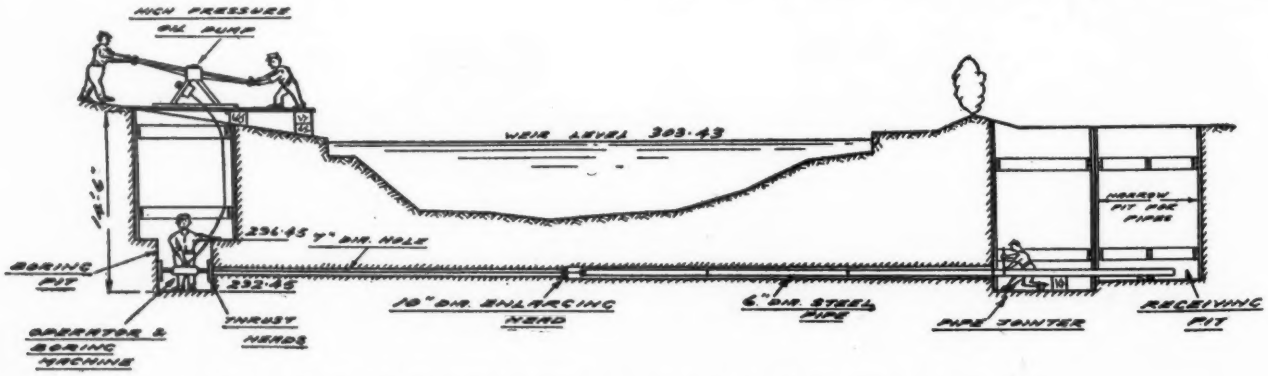
Refuse removed from New York City's sewers is hauled to scows for dumping at sea. Formerly this hauling was done by carts hired at more than $30,000 a year, and filled directly by the cleaning gang. Now the dirt is placed in 4.5 cu. ft. cans, and two trucks equipped with cranes go from gang to gang, empty the cans into their bodies and, when loaded, proceed to the scows; this method is so economical that the purchase cost of the equipment plus one year's operation was less than one year's $30,000 cart hire.

When cleaning sewers, using a Champion sewer cleaning machine, three or four manhole covers are removed for ventilation, and replaced during the work with covers made of steel grating strong enough to support a truck wheel. Instead of hand flash lights, men entering a sewer for inspection or repairs wear a dry-battery lamp fastened on the forehead.

The 8,000 trapped catch basins are cleaned at intervals of 6 weeks to 3 months. These traps are being eliminated where the sewer has a self-cleaning grade. In one section of the city where traffic is heaviest, basins are emptied at night at intervals of 2 or 3 months, all basin-cleaning gangs being detailed to this section for 3 or 4 nights.[H31]

Double Plant For Wastes and Sewage

Circleville, O., treats its sewage and wastes from a strawboard plant in two separate plants, both in the same building; the wastes (which are three times as great in quantity as the combined domestic sewage and cannery wastes) being led directly to the plant by a line of 14″ Transite pipe. Each plant consists of a bar screen; chemical feeders, flash mixers and flocculators; and sedimentation with sludge collectors; with possible chlorination of the final effluent. The sewage sludge is digested in heated digesters; that from the wastes is run into lagoons provided by the strawboard plant. Alum is used as coagulant in the sewage plant, 710 lb. per m.g. giving the best results. In treating the strawboard wastes the use



Forcing drain pipe under canal in England. Pulling in 10″ enlarging head with pipe attached

of coagulants does not seem to be of much benefit, at least within the range of economy. Plain sedimentation reduces the suspended solids 43% to 48% and the B.O.D. 13% to 20%; best results in B.O.D. reduction are obtained by chlorinating the effluent, using 70 to 100 ppm.

In starting the digesters, they were filled with raw sewage, heated and sludge added gradually together with hydrated lime; no difficulty was experienced and gas was available for use within a month.[H32]

Recent Ideas Concerning Trickling Filters

Trickling filters are returning to popularity partly because the activated sludge process is seriously disturbed by considerable fluctuations in either concentration or volume of sewage, while the filter is not—perhaps because the upper layers serve as an equalizing and storage machanism, protecting the lower biological films from sudden changes. Another reason is recognition that the filter not only serves as a biological stabilizer but also has agglomerating and other physical capacities. These have not been fully utilized in the past; to do so, shorter dosing cycles are desirable, with more uniform rates of discharge. Different horizontal strata of a filter perform different functions. In the upper ones, proteins and amino acids are attacked and agglomeration takes place; at the bottom, nitrifying and sulphur oxidizing bacteria predominate. If the upper layers could be declogged readily, as by back-washing, the filter capacity could be increased tremendously. This principle has led to double filtration, the primary filter being washable, with a settling tank between the filters. This procedure, either for removable of large qantities of BOD or reduction of excessive fluctuations in concentration of water reaching the final process of purification (activated sludge or final trickling filter) holds forth much promise.[X23]

Sewer Rentals In Woodbury, N. J.

Woodbury, N. J., has just completed a treatment plant, for which amortization and operating costs will be paid by sewer rentals. Citizens served by water will be charged $8 a year plus 1/3 the water rent. For those not using metered water the charge for the first year is $1 for each person working on or about the premises, after that a minimum charge of $35 a year. Outside city limits, $15 a year for each dwelling, payable in advance. If unpaid for 60 days, 5% penalty is charged. Rentals and fees are a lien upon the property. These rates are expected to more than meet the requirement and will be reduced when actual operating costs are learned, which costs are estimated to be $17,000 a year, while $6,000 is apportioned for retirement of bonds and $5,150 for interest on them.[X24]

Using Sewage Gas at Durham

At Durham, N. C., sludge is digested in three digesters at 82° F. The volatile matter is reduced from 61% to 38% in 50 days theoretical digestion period, producing about 46,000 cu. ft. of gas daily, being 6049 Btu per pound of volatile matter. It is proposed to pipe about 25,000 gals. daily of kier liquor directly to the digestion tanks, estimated to yield 13,000 cu. ft. of gas. Gas is converted into electric power by two 150 hp gas engines, each direct connected to a 100 kw, 2400 volt generator; the power being interchanged with the city's hydroelectric plant and the local power company. There is a gas meter for each digester; also a recording gas calorimeter. Quantity and quality of gas are used for controlling lime additions to

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the digesters, and foaming is unknown. The Btu is maintained at 700 per cu. ft. and the engines average 19.80 cu. ft. of gas per kwh., giving an overall efficiency of 27.5%. The waste heat is utilized by heating the digesters (which takes less than half of it in the coldest weather) and heating the four covered sludge beds, using ¾" pipes laid just below the sand surface. During 1939, 424,490 lbs. of dry solids were removed from 10,000 sq. ft. of covered sand beds, using heat; while the average of the three previous years without heat had been 325,423; and the former would have been 40,000 lbs. greater had not the beds been out of service two months for repainting, etc. The cost of installing this drying bed heating system was about 25 cts. a sq. ft. The cost of replacements and lubrication of the power plant is only about 0.1 ct. per kwh. generated.[X26]

Treating Milk Wastes in New Jersey

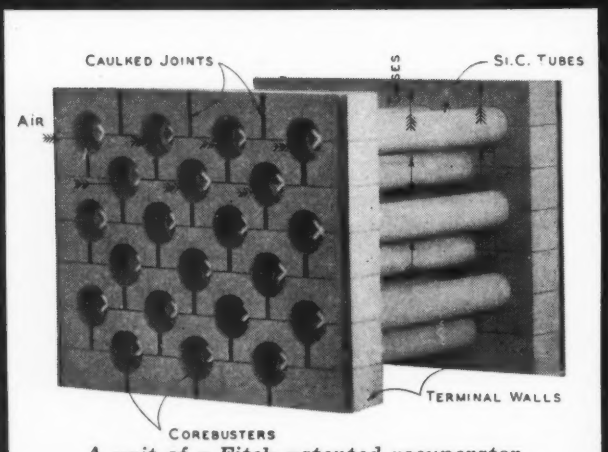
About a million quarts of milk are processed daily in New Jersey, and securing proper treatment of the wastes therefrom is an important duty of the State Dept. of Health. In most recently installed plants the procedure is as follows: Conservation of milk by drip pans, etc.; separation of all clear and very slightly polluted waters from those containing appreciable amounts of milk; settling the latter in tanks operated on the fill-and-draw principle, each tank having a capacity of one day's waste, chemicals (commonly aluminum sulphate) being first mixed with it; discharging the supernatant, mixed with the clear cooling water, into a stream, and the sludge onto filters of cinders or other coarse material. Chlorination of the effluent is desirable to delay decomposition until dilution and reaeration have reduced the oxygen demand.[X27]

Sulfur Dye Waste And Sludge Digestion

Studies of the effects of textile waste liquors upon sewage treatment are being made by the Textile Foundation cooperating with the University of North Carolina. Sulfur dye waste, one of the strongest textile waste liquors, was selected for special study. These studies have shown that sulfur black dye waste in sludge as low as 0.5% by volume is detrimental to digestion as measured by gas production, and that concentrations above 6% virtually stop gas production. Dye waste added directly to the digesting mixture is more detrimental than dye waste removed from sewage by the activated sludge process. Both the dye itself and the materials used in the dye vat appear to retard gas production. Sludge digesting organisms can be acclimatized to sulfur black dye wastes, and seed sludge so acclimatized aids in digesting large quantities of dye waste in a shorter period. Proportioning is very important since, with large quantities of seed sludge, the initial lag in gas production is reduced to a minimum and larger quantities of dye waste are tolerated.[C57]

Elutriation at Annapolis, Md.

During 1939 the Annapolis sewage treatment works began experimenting with elutriating sludge before dewatering, and the first trials showed such definite savings in chemicals, power and filter cloth that it was adopted as a regular procedure. Trials were made with well water, brackish bay water and clarifier effluent for elutriating, and the last proved the most effective and least costly. In conditioning elutriated sludge for vacuum filtration, 1.7% of ferric chloride is used and no lime, whereas before elutriation 7.3% ferric chloride was used.



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Successful runs have been made using commercial alum from the water treatment plant, three times as much alum being required as ferric chloride; but alum was not successful with unelutriated sludge. With only 1.7% ferric chloride the yield of the filter is 8 to 10 lbs. per sq. ft. per hr.; filtering time, labor and power are cut in half by elutriation; and filter blankets last for 123 tons of cake or over 520 hrs. of active service instead of 36 tons and 153 hrs., and they hope to increase this to 300 tons or about 1200 hrs. for a blanket costing $27.[G22]

Bibliography of Sewerage Literature

The articles in each magazine are numbered continuously throughout the year, beginning with our January issue.

c. Indicates construction article; *n*, note or short article; *p*, paper before a society (complete or abstract); *t*, technical article.

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21. Construction of an Inverted Siphon by Thrust Boring. By D. J. Davidson. Pp. 543-544.

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22. p. Improving the Operation of a Small Sewage Treatment Plant. (Annapolis, Md.) By C. G. Weber. Pp. 309-313.

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30. Chemical Treatment at Oshkosh. By R. W. Frazier. Pp. 324-326.
31. Sewer Servicing in New York. By C. W. Williams. Pp. 327-329.
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33. Designing Activated Sludge Aeration Tanks. By R. Eliassen. Pp. 333-334, 346.

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18. Malaria and Drainage Ditches Combined (Memphis, Tenn.) Pp. 62-63, 74.
19. p. Sewage Gas Utilization at Rockville Center, N. Y. By C. G. Anderson. Pp. 68-69.

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6. p. Trickling Filters. By M. Levine. Pp. 10, 11, 42-47.

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34. Laying Heavy Concrete Pipe Under a Fill. By R. V. Terrill. Pp. 20.
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23. Observations on Trickling Filters. By M. Levine. Pp. 27-44.
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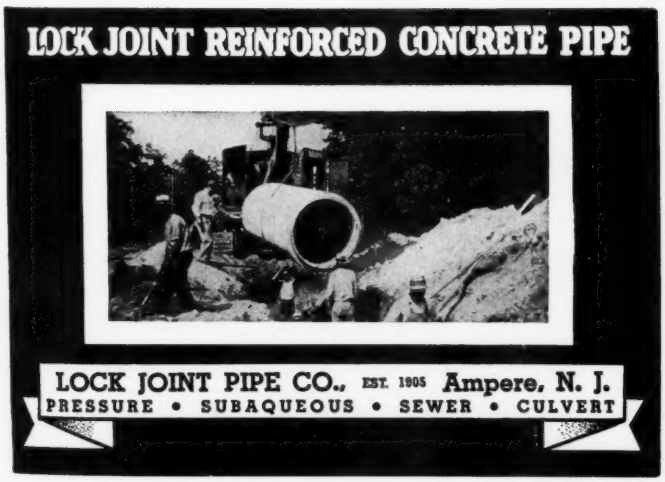
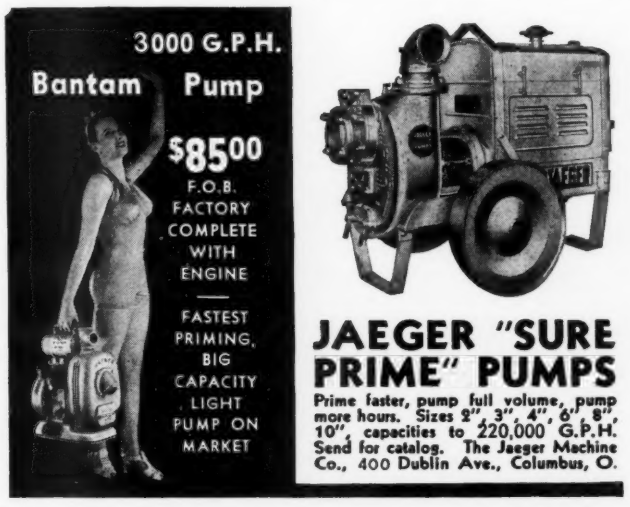
26. Utilization of Power From Sewage Gas at Durham, N. C. By R. S. Phillips. Pp. 58-64.
27. Installation and Operation of a Dairy Wastes Treatment Plant. By C. M. Nichols. Pp. 67-73.
28. Construction of Sewage Treatment Works and Its Relation to the National Economy. By A. Wolman. Pp. 74-81.
29. Sludge Disposal at Cleveland. By G. B. Gascoigne. Pp. 82-89.
30. Sewage Treatment at Buffalo, N. Y. By P. Hansen. Pp. 90-105.
31. Disposal of Sewage and Industrial Wastes at Chicago. By F. W. Mohlman. Pp. 106-114.
32. Need for a Strong National Sewage Works Association. By W. J. Orchard. Pp. 115-125.
33. Abatement of Odor Nuisance at Manasquan Sewage Treatment Plant. By J. K. Van Brunt. Pp. 147-152.
34. Twenty-five Years of Sanitary Progress in New Jersey. By C. Potts. Pp. 153-166.
35. Operating Problems at the Flemington Sewage Treatment Plant. By W. Allegar. Pp. 168-170.
36. Comparison Between Analyses and Turbidimeter Readings. By E. A. Bell. Pp. 171-175.
37. Maintenance of Sewage Pumping Stations. By A. L. Suden. Pp. 176-182.
38. Pretreatment of Industrial Trade Wastes. By W. J. Kee. Pp. 183-191.
39. Experience With Slow Sand Filters in Sewage Treatment. By W. C. Mallalieu. Pp. 192-195.
40. Infiltration: Locating Leaks and Making Repairs. By J. H. Le Chard. Pp. 196-199.
41. Preheating Sludge and Scum Before Pumping to the Digester. By T. Eggertson. Pp. 200-201.
42. Vacuum Drying and Incineration of Raw Sewage Sludge. By H. Parsells. Pp. 202-204.
43. Sludge Drying at the Tenafly Sewage Treatment Plant. By J. K. Adams. Pp. 205-212.

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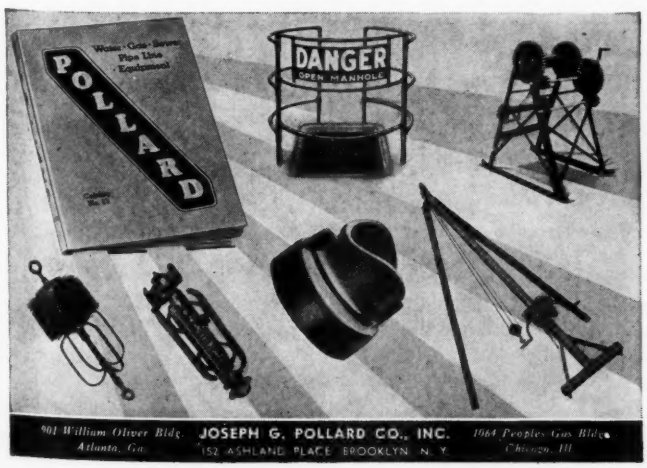
FASTEST PRIMING, BIG CAPACITY, LIGHT PUMP ON MARKET
JAEGER "SURE PRIME" PUMPS
Prime faster, pump full volume, pump more hours. Sizes 2", 3", 4", 6", 8", 10", capacities to 220,000 G.P.H. Send for catalog. The Jaeger Machine Co., 400 Dublin Ave., Columbus, O.



40 Years of WATER PURIFICATION
For more than forty years we have specialized in the art of water purification. We manufacture a full line of Water Filters, both pressure and gravity types; Zeolite Water Softeners; Swimming Pool Recirculating Equipment; and various forms of Water Rectification Units. Inquiries are invited on all problems of water treatment.
ROBERTS FILTER MFG. CO.
640 COLUMBIA AVE. DARBY, PA.

Buried Thermometers Register Depth of Frost in Clay and Gravel Soils

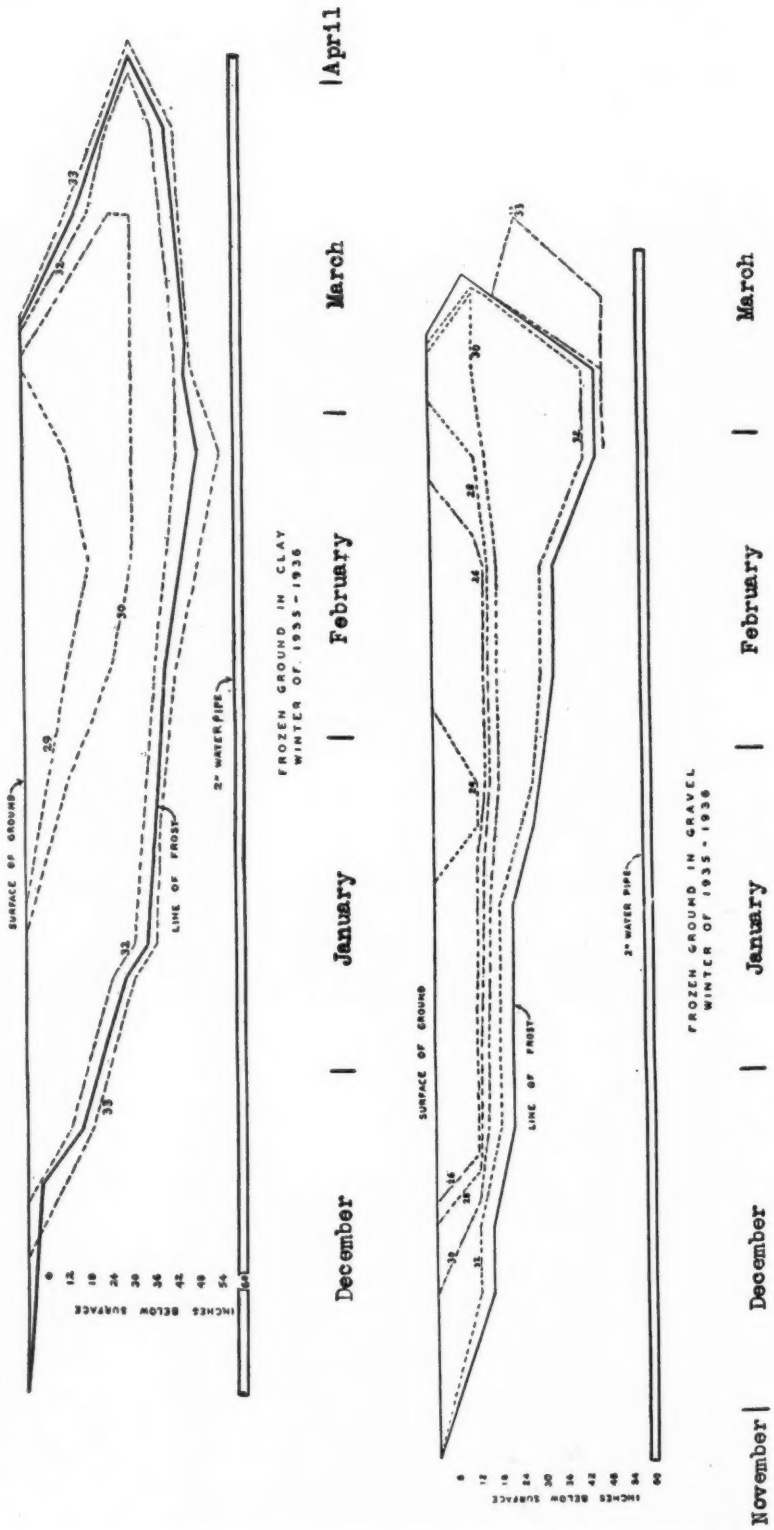
THE Portland (Me.) Water District, to learn how temperatures of the ground within 5 ft. varied during the winter, buried thermometers at various depths in both clay and gravel soils. The daily records were plotted, and are shown in the accompanying diagrams, the heavy lines showing the depth of frost.

In gravel, the frost began to go down on Nov. 27 and reached its lowest point—45 in. below—on Feb. 27, remained there until March 7, when it began to thaw at the bottom. On March 10 it began to thaw on the surface and on March 16 the last frost melted 15 in. below the surface.

In clay, the ground began to freeze on Dec. 15 and reached the lowest point—48 in. below—on Feb. 27; then the frost line rose slowly until April 3. Meantime, on March 10 the surface of the ground began to thaw and the frost line moved down until it met the lower line on April 3.

These diagrams show that gravel is much more responsive to changes of temperature than clay, but the maximum depth reached by both was about the same. However, a pipe buried only 3 ft. would be above the frost line for 3 weeks in gravel but for 11 weeks in clay.

The above data were given by Harry U. Fuller, chief engineer of the Portland, Me., Water District in a paper before the Maine Water Utilities Assn. A previous paper before the Association (see PUBLIC WORKS for May, 1935, p. 36) described studies on frost penetration which had been made in Portland, and its relation to accumulated temperature deficiency. A study of this relation and a record of accumulated temperature deficiency for the current year should permit water superintendents to learn, without actual digging, about how deep the frost is penetrating and when it can be expected to leave the ground. There seems to be a lag of several days between temperature deficiency and frost penetration, the latter even continuing to increase after the temperature rises regularly above 32°.



Keeping Up With New Equipment

Plain End Pipe with Tru-Line Collars

Plain end pipe are manufactured of an all shale material, unglazed, thoroughly vitrified and in laying lengths of 24 ins. The ends are smooth so that the flow of liquid through the pipe will not be retarded. The thickness of the barrel of the pipe conforms with ASTM specifications for vitrified sewer pipe. The pipe is made in 4-, 6- and 8-inch diameter.

Perforated plain end pipe are manufactured of the same material; perforations are approximately ½ inch in diameter and are placed in straight rows, 7 holes to the row. The rows of perforations extend around half the circumference of the pipe, giving 28 perforations per length of 4-inch, 42 perforations per length of 6-inch, and 56 for 8-inch. The inside of the barrel is kept smooth. Dimensions correspond to ASTM specifications.

Tru-line collars are of the same all-shale material. These not only join the sections of pipe and keep them in line and grade, but also afford extra ingress for drainage water. Lugs or flutes provide space between the collar and the pipe. Collars meet crushing, absorption and acid solubility tests, just as the pipe does.

Specifications and full data on this pipe and its uses for highway, airport and other drainage work will be sent on request by the Bowerston Shale Co., Bowerston, Ohio.

Perforated drain tile and how they are installed for highway drainage

Rubber Hose for Sewage Treatment

A new application of rubber hose for sewage plants is reported by The B. F. Goodrich Company, Akron, Ohio, in the use by the Chicago Sanitary district of a special 8 inch inside diameter Armorite lined hose for loading sludge into cars. Armorite is a special rubber compound designed to resist abrasion and has been widely used in fields where that condition is faced.

Galion 401 Motor Grader

The Galion 401 motor grader is a light but powerful machine for maintenance work in townships, counties, cities and villages. It can be supplied with an enclosed cab and equipped with a multiple blade drag, a scarifier or a snow plow. It weighs about 8,000 pounds, has a wheelbase 14 ft. 4 ins. long and an 8-ft. blade. Full data are given in Bulletin 255, Galion Iron Works & Mfg. Co., Galion, Ohio.

Automatic Metering of Asphalt Cement

An automatic precision device for accurately measuring the precise quantities of ingredients in asphalt-cement mixes, the Fluidometer, is announced by the Brayer Instrument Co., Buffalo, N. Y. It eliminates the "bucketing" operation and affords a dependable method for conveying directly and without human attention the precise quantity of A-C into the mixer.

The Fluidometer is suited to present mixing plants and can be adapted to hot or cold mixing, using petroleum or native asphalt cement or other binding agents.

Operation is simple. The push of a button switch opens a motor operated valve starting A-C flowing through the meter. The meter drives the control mechanism, which can be shown on an indicator, to deliver the quantity desired. A-C is metered with a maximum variation of less than one-half of one per cent.

Hetherington & Berner Inc., Indianapolis, Ind., are the sole distributors for the Fluidometer system on bituminous paving plants.

A New Street Sweeper to Package Litter

The new Van Dorn street sweeper is described and illustrated in an attractive 4-page catalog. This sweeper is designed to collect and package litter, and extra containers may be placed along the street at convenient points. No brooms or shovels are needed to complete the sweeping job, and there are no piles of dirt in the street. Full data sent on request. Van Dorn Iron Works Co., Cleveland, Ohio.

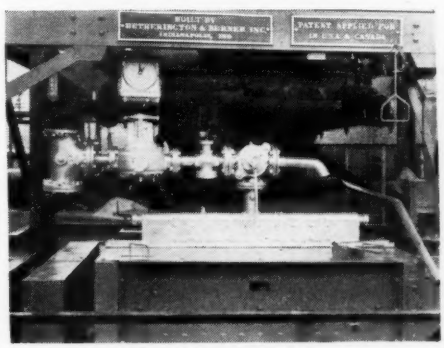
Protective Coatings for Waterworks

Standard specifications of the American Water Works Association are included in this booklet, along with brief data and illustrations showing pipe lines coated with Barrett materials. The Barrett Co., 40 Rector St. N. Y.

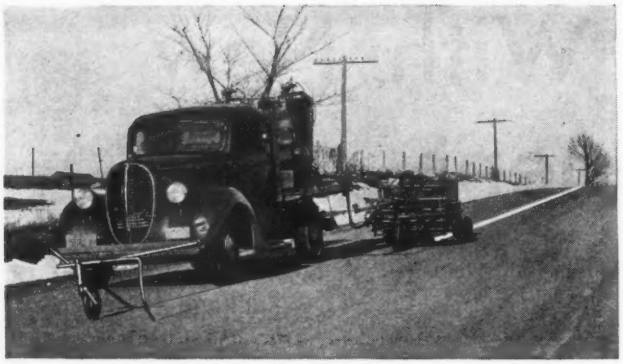
McNulty Unit Sewage Flow Regulator

The McNulty Engineering Company, of South Boston, Mass., has just announced a new unit regulator to eliminate the need of large chambers as well as field assembly, since each unit is completely factory assembled and adjusted. Set to pass a specified quantity and ready for insertion in the lines, the new McNulty units are available in all the popular sizes.

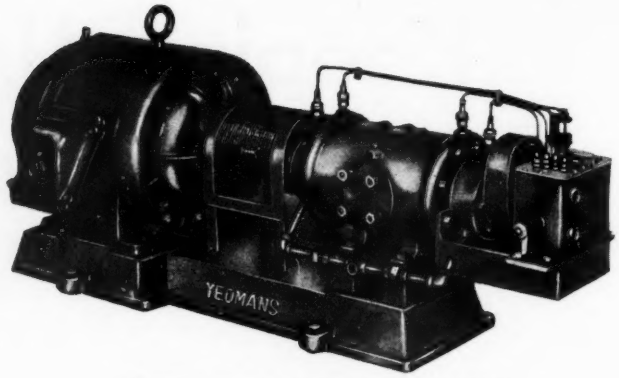
A few of the outstanding advantages of the new McNulty unit regulator are: its inexpensiveness; the elimination of the float chamber and the reduction in regulator chamber size; its adaptability to existing manholes; its corrosion-resistant construction as it is regularly built entirely of Everdur bronze or aluminum, dependent on the type of sewage to which it is to be exposed; tail water control; the ease and simplicity of installation; low maintenance requirements as it is self-cleaning; and, most important of all, accuracy.



The H & B fluidometer



The Meili-Blumberg traffic line marker



Yeomans rotary sewage gas compressor

1, 2 or 3-Line Traffic Line Marker

The Meili-Blumberg Corporation of New Holstein, Wisconsin, has developed a new automatic marker which is said to take care of every conceivable type of traffic line marking job. It automatically applies single, double or triple center lines or road lanes, solid or intermittent, in one, two or three color combinations. Either paint or hot asphalt may be used.

The entire operating mechanism is easily controlled by three centrally located levers. Length of intermittent marks may be predetermined and the machine adjusted to produce the desired length of line, either automatically or by manual control at the operator's discretion.

Clean cut lines are assured by the use of internal atomizing type spray guns and floating side shields. Provision is made to clean the road surface ahead of the spray guns by blowing away the dust before the paint is applied. Complete data on request.

New "Cedarapids" Asphalt Plant

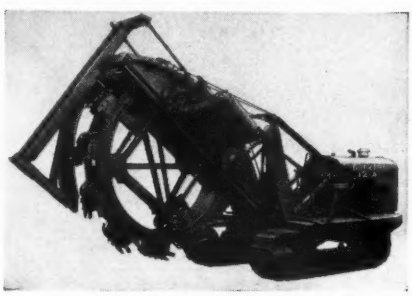
The Iowa Manufacturing Company, of Cedar Rapids, Iowa, has issued a loose leaf catalog covering hot and cold mix asphalt plants and accessories. The book is made up of an introductory discussion of the future of bituminous construction and separate bulletins dealing with individual units and accessories.

The catalogs include four types of asphalt plants: the hot or cold mix asphalt plant, the speedline portable asphalt plant, the traveling road-mix asphalt plant and the rapidmix. asphalt plant. It illustrates several combinations of the batch type hot or cold mix plants, including both stationary and portable tower type equipment. In addition there are individual bulletins illustrating driers, pug mills, hot and cold elevators, feeders, storage hoppers, screens, batchers, asphalt buckets, heater sets, scales and other accessories.

Complete specifications and dimension charts are given in each bulletin. Typical plant set-up drawings are shown for the larger plants; the bulletins are well illustrated and the information is valuable for all road builders, engineers, highways commissioners and contractors. Catalogs or separate bulletins will be sent. Iowa Manufacturing Company, Cedar Rapids, Iowa.

Model 12A, New Buckeye Trencher

The Buckeye Traction Ditcher Co., Findlay, Ohio, has announced an addition to their line of rotary wheel type and boom type trenchers. The excavator wheel frame provides greater strength. A "fluid coupling," which is optional



Digs anything but solid rock

equipment positively protects transmissions from sudden shocks and prevents engine stalling.

The Model 12A cuts trench up to 26" wide and up to 5' 6" deep. Overall width (exclusive of spoil conveyor) is only 6' 8"; overall digging height is 8' 1¼". A wide range of cutting feeds, conveyor belt speeds and travel speeds are provided for all types of work. The 12A digs anything short of solid rock, working in any terrain.

Spaders and Trench Diggers

Spaders and trench diggers are illustrated and fully described in the Sullivan four-page, two-color Bulletin—87-K. The Sullivan M-2 spaders are built for shaft sinking, tunnel and trench work, and light demolition. They are easy on the operator. Handle grips fit the hand, an air cushion at the end of the cylinder relieves jar, and exhaust ports are arranged to deflect exhaust away from the operator. They are easy to dismantle. Sullivan Machinery Company, Michigan City, Indiana.

Yeomans Rotary Compressors for Sewage Gas

The new Duluth sewage treatment plant utilizes Yeomans rotary compressors and a 36-ft. Hortonsphere tank for conserving digester gas and providing an uniform volume at all times. The compressors take the gas at pressures of 8 to 10 inches of water and store it in the tank at 25 to 30 pounds pressure, whence it is available for use as needed through pressure reducing valves. Burlingame, Hitchcock and Estabrook are the consulting engineers.

Explosimeter Model 2

The Explosimeter Model 2 is compact and light in weight, with a simplified electrical circuit featuring a single filament and single control knob.

True one-hand operation of the instrument is an advantage—one hand is left entirely free. Immediate response to combustible gas concentrations is provided by the reading meter, with a positive reading on the second squeeze of the bulb. This model is powered by standard flashlight batteries contained in a separate compartment from the working parts.

Bucyrus-Erie H-28 Scraper

The new Bucyrus-Erie H-28 is a 2-wheel hydraulic scraper built for use with tractors rated at 25 to 35 horsepower. It has a struck capacity of 2½ cubic yards but will, according to the manufacturer, heap to loads of 3 or 4 cubic yards. Since the H-28 with its tractor can be loaded on a regular truck and hauled within usual dimension and load limits, no special permit is needed to haul it over the highways; thus it becomes especially handy for work involving fast moves from job to job. The H-28 can also be used with a rubber-tired tractor, making a complete dirt-moving and traveling layout, and a high speed all-on-rubber hookup that will not damage hard-surfaced roads.

The back-dumping feature makes it possible for the H-28 to dump its loads over the edge of a bank or a fill; over the edge of a ramp into trucks or cars; or end-dump against foundation walls, bridge abutments, or around culverts.

PERSONAL NEWS

The following new appointments as county engineers have been reported:

Col. H. Stroupe, Logan County, Paris, Ark.

A. L. Meger, Pipestone County, Pipestone, Minn.

Edw. F. Metsger, Wood County, Bowling Green, Ohio.

The following new appointments as city managers have been reported:

R. R. Rivers, Supt. Public Works, Green Cove Springs, Fla.

H. R. Cheek, Big Stone Gap, Va.

The following new appointments as city engineers have been reported:

Victor McCormick, Atlantic, Iowa.

R. A. Trebilcock, Norway, Mich.

The following new appointments as water works superintendents have been reported:

C. Fisher, Belle Plaine, Iowa.

Fred Holberg, Missouri Valley, Iowa.

W. K. Ream, Longview, Texas.

John K. Hoskins, Senior Sanitary Engineer, U. S. Public Health Service, has been relieved of his work on Ohio River Pollution, and ordered to Washington to act as chief engineer of the Public Health Service.

R. T. Steindorf has been appointed district manager of the Chicago office of the Chain Belt Co., Milwaukee, Wisc.

Frank W. Herring, Executive Director of the American Public Works Association, has been granted a leave of absence to Jan. 1, 1941, to become assistant director of the National Resources Planning Board. His headquarters will be in Washington.

Neal B. Thayer is Superintendent of Water Works, Elkhorn, Wisc., and has been for several years. In our June issue, it was incorrectly stated that Edward Drewery was superintendent.

Victor McCormick has been appointed City Engineer of Atlantic, Iowa.

M. E. Mutchler, general sales manager of the Sterling Engine Co., Buffalo, N. Y., died July 22.

Arizona Sewage & Waterworks Association

The fall meeting of this association will be held at Safford, Ariz., Oct. 4 to 6, 1940. F. C. Roberts, Jr., Phoenix, Ariz., State Sanitary Engineer, is secretary of the association.

Virginia Section, AWWA

The 1940 annual meeting of the Virginia Section, AWWA, will be held at the University of Virginia, Charlottesville, Va., September 5 and 6. H. W. Snidow, 119 State Office Bldg., Richmond, Va., is secretary.

California Section, AWWA

The 21st annual meeting of the California Section, AWWA, will be held at Los Angeles, Calif., Oct. 21 and 22, with headquarters at the Hotel Biltmore. J. R. Barker, 320 Market St., San Francisco, Calif., is chairman of the exhibit committee.

1940 Public Works Congress

The 46th annual conference of the American Public Works Association will be held at the Book-Cadillac Hotel, Detroit, Mich., Sept. 30 to Oct. 2.

Examination for Civil Engineers

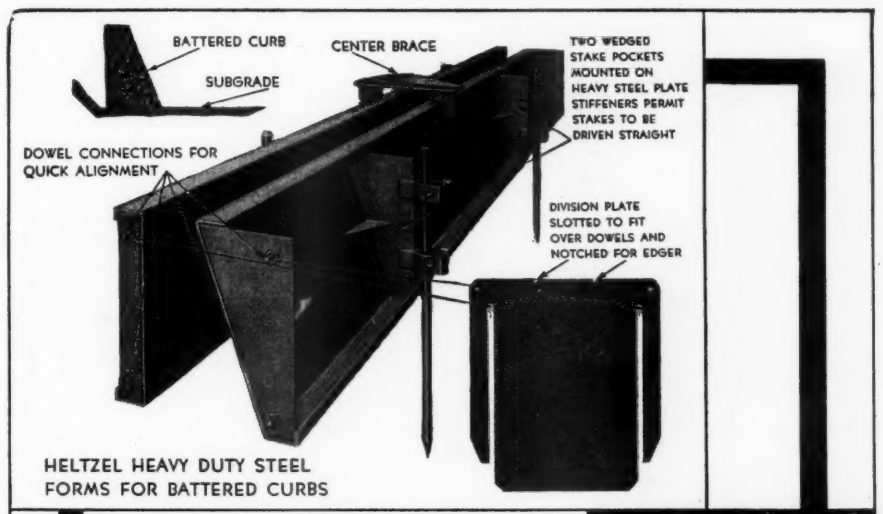
The U. S. Civil Service will receive applications until Aug. 29 (until Sept. 3 for those living in Colorado and west) for appointment as civil engineer. Examinations will cover four grades, with salaries from $2600 to $4600 per year. Applicants must not have passed their 55th birthday. Full information from the U. S. Civil Service Commission, Washington, D. C., or from the Board of Civil Service Examiners at any first or second class postoffice.

Sewage Chlorination:

Problems and progress in sewage chlorination are covered in Technical Publication No. 473, published by Wallace & Tiernan Co., Newark, N. J. 16 pages of valuable and informative material. Sent on request.

Material Handling:

A 32-page booklet on the use of the crawler crane for handling heavy materials. Many uses for such equipment are pictured and described. Bulletin LCC-1, Bucyrus-Erie Co., South Milwaukee, Wisc.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SUBGRADE
CENTER BRACE
TWO WEDGED STAKE POCKETS MOUNTED ON HEAVY STEEL PLATE STIFFENERS PERMIT STAKES TO BE DRIVEN STRAIGHT
DOWEL CONNECTIONS FOR QUICK ALIGNMENT
DIVISION PLATE SLOTTED TO FIT OVER DOWELS AND NOTCHED FOR EDGER

HELTZEL HEAVY DUTY STEEL FORMS FOR BATTERED CURBS

Heltzel Heavy-Duty Steel Forms for constructing battered curbs. Two double wedged stake pockets mounted on vertical stiffeners permit all stakes to be driven vertical — even on the battered side. Yoke type division plates and dowel connections make this form the simplest to set and strip. Send your specifications for complete quotations or write for complete information and catalog S-20.

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- BINS, Portable and Stationary
- CEMENT BINS, Portable and Stationary
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- CURB AND GUTTER FORMS
- SIDEWALK FORMS
- SEWER AND TUNNEL FORMS
- CONCRETE BUCKETS
- SUBGRADE TESTERS
- SUBGRADE PLANERS
- TOOL BOXES
- FINISHING TOOLS FOR CRETE ROADS

HELTZEL STEEL FORM & IRON CO.
WARREN, OHIO · U. S. A.

Fairbanks-Morse Vertical Single Phase Motors

Fairbanks - Morse has recently announced vertical single phase motors in sizes from ¾ to 5 hp. which, because of the combination of electrical and mechanical characteristics, are unusually adaptable for operation in isolated localities where small pumping units are so often located.

Dripping or splashing water will not harm these motors under normal operating conditions since the design prevents water from reaching vital parts. The frame, bearing brackets, and enclosing covers give maximum protection

FM Waterproof Motor

consistent with adequate ventilation. A highly desirable characteristic is the exceptional quietness with which the motors operate. Even at speeds of 3600 r.p.m. they are considered unusually quiet and free from vibration.

Solid or hollow shaft modifications can be furnished. The solid shaft units are usually direct-connected to a pump or machine through a flexible coupling. The hollow shaft unit is particularly well adapted to vertical pump applications because of the advantages of compactness, permanent shaft alignment, and high thrust capacity.

Cambridge Electron-Ray pH Meter and Thermionic pH Recorder

The Cambridge Electron-Ray pH Meter is sensitive to .005 pH; it reproduces readings to .01 pH and incorporates in place of the conventional null-point indicator, an Electron-Ray tube which is practically immune to damage from mismanipulation by the operator. Its glass electrode enables universal application. Scaled in both pH and Millivolts, the instrument provides a high degree of accuracy for the determination of pH values as well as oxidation-reduction potentials without applying a conversion factor. This conveniently portable meter operates directly from the 110-125 volt supply line.

The Cambridge Thermionic pH Recorder permits continuous pH recording. With it, pH values can be continuously recorded with laboratory accuracy, under plant operating conditions. This new Cambridge instrument with glass electrode for universal application now solves problems which confronts many processors. The complete equipment operates directly from the 25 or 60 cycle supply line and the electrode system may be located at considerable distance from the recording unit.

Further data from Cambridge Instrument Co., Inc., New York, N. Y.

Meter for Measuring Heavy or Corrosive Fluids

Viscous and corrosive fluid flow: "Straight-thru" design without orifice plates and pressure connections eliminates difficulties normally experienced in measurement of flow of viscous and corrosive fluids. Used to measure flow of tar, ammonia, sulphuric acid, heavy fuel oil, and so on. Design and installation drawings are reproduced. No. 2100. Cochrane Corporation, Philadelphia, Pa.

Proportioneers Sells a 125-unit Batch

Proportioneers, Inc., Providence, R. I., announce the sale of 125 hypochlorinators to the A. T. McIntosh Co., Chicago, for installation in a real estate subdivision. Every home will have its pumped water supply with a special chlorinator.

To Locate Quickly Lost Valves and Shut-Offs

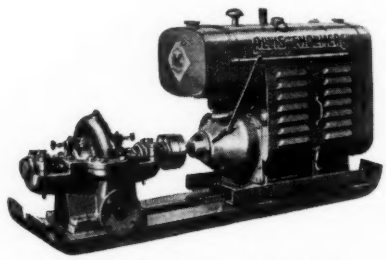
This is an instrument that will rectify the errors in your filing system whereby records are lost or misplaced or reference marks are changed. It is of the dipping needle type and is different in that it permits the operator to stand upright and read the needle directly. It is said to be able to locate valves, etc., through concrete, macadam or other type of pavement. An instructive and interesting folder on request. Aqua Survey and Instrument Co., 1409 Marlowe Ave., Cincinnati, Ohio.

Easy to Find Lost Valves

Engine Driven Centrifugal Pumps

To provide independently powered pumps for drainage, irrigation, gravel washing plants, construction jobs, and similar applications, the Allis-Chalmers Mfg. Co. has introduced a line of centrifugal pumps driven by gasoline power units. Since these units are entirely independent of any outside source of power, municipal and private water suppliers use them as standby units in emergencies when other sources of power fail.

Power units are available in five sizes (8 to 110 H.P.) and with a



AC Engine Driven Centrifugal

choice of fuels: gasoline, kerosene, distillate, natural gas, or butane. All power units have valve-in-head medium speed engines, with removable cylinder liners, efficient cooling systems, force feed lubrication and a variable speed governor.

The centrifugal pumps are horizontal shaft, single stage, single or double suction pumps designed for handling liquids at normal temperatures with maximum efficiency. To facilitate handling, the engines and pumps are mounted on a base and are available in many combinations to meet various requirements in quantity and pressure up to 5,000 gallons per minute and 100 foot head.

A folder (Form MS 253) describing these engine and pump units may be obtained from the Tractor Division, Allis-Chalmers Mfg. Co., Milwaukee, Wisconsin.

Pittsburgh Equitable-Merco Nordstrom Field Service Truck

As a service and convenience to their many customers in the Midwest, the Pittsburgh Equitable Meter Co. and subsidiary, the Merco Nordstrom Valve Co., now have in operation, from their Chicago office, a completely equipped field service truck.

This truck is fitted with the necessary tools, lubricants and test apparatus to handle properly the field maintenance of EMCO and Nordstrom products. It is in charge of Paul Payton, service engineer. Captain A. E. Higgins, Sales Manager, also announced that a similar unit has been ordered for use in the Mid-Continent area, to operate out of the Tulsa office and that additional service trucks would be placed in service in the near future in other sections of the country.